DEPARTMENT OF LANDS AND FORESTS
FORESTRY BRANCH

THE

FOREST RESOURCES

OF

ONTARIO

PROVINCE OF ONTARIO

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THE FOREST RESOURCES OF ONTARIO

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I. INTRODUCTION

Each summer since 1919 systematic forest surveys have been conducted by the Ontario Forestry Branch to secure a knowledge of the forest conditions and an inventory of the forest resources of the province of Ontario. To date this work totals 48 million acres. Besides the results from these surveys, information has been secured from forest inventories by pulp and paper companies covering another 7 million acres, and lately information has been obtained through Dominion topographical surveys on an area of 13 million acres in the Kenora-Patricia portion of Ontario which comprises with general boundaries the location of timber, areas of reproduction and unproductive areas.

Under the various types of survey during the last ten years in all some 73 million acres of forest have been examined. This total forms nearly two-thirds of the 118 million acres under organized protection from fire. Since the various forest surveys have been distributed generally over the province, the information arising out of each has been applied to adjoining unexamined areas, the general character of which is known to be similar.

With the foregoing field work as a basis the forest area of Ontario is described under eight regions, and tables at the end summarize the conditions and present an estimate of the remaining timber resources.

II. FACTORS AFFECTING FOREST CONDITIONS

The environment in which a tree grows is stated usually as made up of two groups of factors—the soil from which the tree derives water and all nutritive materials, except carbon dioxide—and secondly the energy from the sun which dominates the climatic environment of the tree through air temperature, precipitation and wind. Climatic factors as a group rank with soil in their influence on forest distribution, reproduction and growth, and possibly also on

the properties of the products of the forest. If there is included under climatic factors a group, comprising all those which affect the value of the luminous and other rays of the sun; and in the case of soil, to include drainage as well as quality, the factors which determine the environment in which a stand of trees is growing are fairly well outlined.

The problem of forest distribution, however, cannot be understood completely unless two other groups of factors are considered. First, there are the broad plant migrations which have occurred during the retreat of the last continental ice sheet and since, and the topographic features which favoured species in some localities and limited its spread in other directions. Secondly, there are external influences which have played an important part in the development of the forest since the retreat of the last ice sheet. Among the most apparent of these influences have been forest fires, although insect attacks and tree diseases have played an important part. The forests, rather than developing naturally under the influence of soil and climate, have been turned aside by external influences which have attained in many cases a controlling position, accounting for the present conditions of the forest.

The inter-relation of all the factors complicates the entire subject to such an extent that a clear understanding of our forest resources will depend upon consideration of:— climate, through temperature and precipitation, which in its general aspect has a fairly constant influence; geological formations and deposits which form the basis for the discussion of soil and drainage conditions, and finally the group of external influences, forest fires and logging operations coincident with the development of the province which have set up artificial conditions and destroyed the natural relationship of forest cover to climate and soils.

1 CLIMATE

If viewed the world over or with respect to the continent of North America there is an evident relation between plant distribution and climate. The study of the distribution of individual species leads inevitably to a study

of climatic environment. There are for each species particular climatic conditions which limit distribution; it may be the late frosts in the spring and early fall frosts, the extreme low winter temperatures, or heat of summer, or the periodic occurrences of drought. Very little is known concerning the limiting climatic requirements of our tree species, and until such is determined certain problems in tree distribution and growth must remain unsolved.

The gradual change in temperature and precipitation from east to west and from the south to the north of the province is shown in the regional summary of Table I.

Table 1

Summary of Climatic Factors by Regions

Forest Region	Average Temperature Degrees Fahrenheit			Average Precipitation Inches Rainfall			Growing Season Days
	Summer	Winter	Annual	Summer	Winter	Annual	
1. Ottawa-Huron.	61.2	15.2	39.2	12.57	9.93	33.80	105
2. Sudbury.....	59.1	11.3	36.4	10.97	7.64	28.46	73
3. Rainy River.....	59.6	8.3	33.6	12.44	4.40	23.74	93
4. Lake Superior.....	56.7	7.7	33.4	10.61	7.03	26.01	67
5. Central Divide.....	56.6	6.4	32.6	11.78	7.78	28.81	57
(a) Kenora Extension	58.8	4.7	33.1	13.24	5.21	25.64	77
6. Clay Belt.....	58.7	7.0	34.0	12.42	7.68	29.43	76
7. Coastal Plain.....	56.2	2.0	30.4	10.77	4.48	20.95	80
8. Central Patricia....	55.8	1.0	28.8	8.97	3.00	16.04	81

Note:—Summer period, June 1st to October 1st (4 months); winter period, December 1st to April 1st (4 months).

The stations from which meteorological data are available are limited in number and have been in operation for varying lengths of time; it is therefore probable that the figures will be affected in some cases as more data are accumulated. In the Coastal Plain region there is only the station at Moose Factory and in the Central Patricia region the station at Fort Hope. In the remaining regions there are a number of stations where continuous records over a period of years are available.

When a relatively small area, such as the province of Ontario, is considered, the relationship between climate and

distribution, owing to the more limited range of variation in climate, cannot be separated readily from the influence of the locally effective factors, soil and drainage. Over the extent of the province conditions of temperature and rainfall do not appear to present differences sufficient to be the controlling factor, either for tree distribution or growth. Low winter temperatures are recorded along the Height of Land and north, but average temperatures during the growing season range only from 61.2 degrees F. in the Ottawa-Huron region to 55.8 degrees F. in Central Patricia. The average annual rainfall varies from 33.80 inches for the Ottawa-Huron region to 23.74 inches in the Rainy River region, and, although the mean annual precipitation is less in the western section of the province the rainfall during the growing season is approximately the same in the two regions. The Coastal Plain and Central Patricia regions have, from available figures, a smaller amount of rainfall, with 20.95 and 16.04 inches respectively.

It has been generally thought that the explanation of the limited forest growth in the northern parts of the Hudson bay slope was largely to be looked for in the climatic conditions; however, this contention does not appear to be well founded if length of growing season is considered. The shortest growing season, only 57 days, is that of the Central Divide region, due to the effect of altitude on temperature. All along the Height of Land country it does not exceed 77 days, whereas the length of growing season at Moose Factory averages 80 days. It therefore appears that in the Coastal Plain region the low, flat-lying, poorly-drained land controls the type of tree growth, with climate playing a comparatively insignificant part.

The ability of a tree species to establish itself in a given locality in competition with other species depends frequently on very small differences in site. The very local differences in topography and exposure are largely climatic in their working in that they affect the value of the energy of the sun. Many of these conditions are very local, as evidenced by the variations in composition and growth found in travelling through any section of forested land.

Where a tree species is growing near or beyond its northern geographical distribution it is generally found on protected southern exposures and under the suitable soil and drainage conditions around lakes and along streams. The favourable growing conditions permit these species to enter into competition on such locations where the limiting factor of climate is offset by the ample locally effective factors of soil, drainage and light. Thus white and red pine are found in small patches as far north as the Coastal Plain and Central Patricia regions. Jack pine is found on sandy soils up to James bay, although few commercial stands occur from the Clay Belt north. Hard maple grows well on the Loch Lomond watershed, district of Thunder Bay, where a high range of hills on the north protects a long, southeasterly-facing slope. These outlying occurrences of many species are an expression of favourable local environmental conditions in a region where the general conditions favour other species.

2 GEOLOGY AND SOILS

Present conditions relating to the existence and distribution of forest and other plant life obviously depend upon the succession of physical changes which have taken place during the past. In the case of Ontario the matter is especially important, not only due to the large area affected, but also because the greatest changes took place in the period immediately preceding the present one, involving extremes of temperature and physical modification of the land surface.

The dominant feature of the geology of Ontario is the inclusion of almost the entire area of the province in the great U-shaped "Canadian Shield" surrounding Hudson bay. The rocks of this formation are among the oldest known and consist largely of crystalline granite and gneiss. The area in general is of low relief, consisting of series of low ridges and hills striking frequently in a northeasterly and southwesterly direction. The highest elevations along the Height of Land rarely exceed 1,500 feet above sea level. The drainage of the "Canadian Shield" is made up of many rivers, which usually consist of a number of lakes with short

stretches of river between, where the drainage spills over the rock ledges characteristic of the area. The physiographic features were modified by the last continental ice sheet during the advance of which it was largely an area of denudation, while the soil and surface features were modified sometimes by the sequence of events accompanying its retreat.

In Palaeozoic times a large area around Hudson and James bays and also a considerable area in southern agricultural Ontario was covered by ocean waters and various deposits of sedimentary rocks were laid down over the Pre-Cambrian. In southern Ontario this formation is almost wholly south of the forest district and, although not entirely agricultural land, is not included in the forest area of the province. The Palaeozoic on the James bay slope occupies an area of about 88,800 square miles, consisting chiefly of limestone and sandstone. The formation lies almost horizontal, tilted upward somewhat at the rim, giving an average drop of about two feet per mile towards James and Hudson bays.

Although at least five glacial periods have been recognized, during each of which the ice sheets have covered the entire province, the last or "Wisconsin" ice sheet so modified the land surface that the evidence of previous glaciation is covered up. At the time of the ice sheets the vegetation now occupying the area covered, must have been forced far south beyond the edge of the ice, where it occupied a zone with a climate corresponding to that in which it now lives. The deposits laid down during the retreat of the last ice sheet modified the surface condition, especially where the receding ice at various stages blocked the natural outlets and caused the formation of large inland bodies of water. At its greatest extent the ice sheet extended south of lake Ontario and curved far south of the Great Lakes up towards the International Boundary. The recession of the ice sheet followed its original contour, so that the western section of Ontario was uncovered first. As the ice sheet receded north of the present watershed of the Mississippi river a large glacial lake, known as lake Agassiz, was formed, blocked

by the Height of Land on the south and the waning ice sheet on the north. As the ice withdrew farther to the northwest the waters of the lake spread over large areas of Manitoba, Saskatchewan and across the boundary into United States. In Ontario lake Agassiz extended to the east of Rainy lake, district of Rainy River, and the western end of lac Seul from which it struck in a northwesterly direction to the Ontario-Manitoba boundary. On the north and east the shore of the lake was formed by the ice sheet. The deposits of glacial lake Agassiz form the agricultural land in the vicinity of Emo, district of Rainy River, and also the country in the vicinity of Dryden, district of Kenora. It is possible that other areas of potentially agricultural land occur within the area of the province formerly covered by lake Agassiz. The occurrence of the land areas suited only to forestry purposes in this area is due to the diversity of deposits. Sand and gravel as well as clay were laid down in different portions of the lake, and at some places the shore-line was either rock or the ice front under which condition deposits may be lacking altogether or of a very coarse nature. The shore-line of lake Agassiz has been located definitely in the prairie country, but has not been followed in detail in the wooded section of Ontario. Owing to the difficult means of transportation it is probable that the outlines of the glacial lakes will remain general for some time. With the continued retreat northward of the ice sheet lake Agassiz finally found an outlet, the Nelson river came into existence and the lake came to an end.

The sequence of events in the eastern section of the province may now be traced. As the ice sheet withdrew from the Great Lakes basin possibly several lakes came into existence for a short time. The largest of these and the most important from the standpoint of deposits was lake Algonquin, which occupied the basins of lake Huron and lake Superior and as well covered large areas north and east of the present lakes. If lake Algonquin is taken at the time of the Trent Valley outlet and when the ice margin occupied a position along the Height of Land northwestward from Sudbury, lake Algonquin extended roughly from the Height of Land south, including the basin of lake Nipigon,

and eastward to a line roughly from the west of lake Nipissing to the east of lake Simcoe. In this area lake deposits are to be found, including the agricultural lands in the vicinity of Fort William, Nipigon, Sault Ste. Marie and Sudbury. To the south and east the deposits are largely of sand piled up in the form of beaches. When the ice sheet had withdrawn still farther the waters found an outlet at North Bay to the Ottawa river, and lake Algonquin was succeeded by the Nipissing Great Lakes. These lakes followed roughly the outline of the present Great Lakes, extending somewhat farther inland—the deposits are of minor importance in Ontario.

North of the Height of Land a lake, known as lake Ojibway, was formed as a result of the damming of water by the receding ice sheet on the north and the watershed on the south. It is probable that for a time at least lake Algonquin joined lake Ojibway over the Height of Land, with a possible overlapping of deposits in some sections. About the time of lake Ojibway a glacial lake, usually known as lake Barlow, occupied the Timiskaming basin. The similarity of deposits of these two bodies of water suggests that they were probably joined for a considerable period, although their exact relationship is not known. The deposits of these lakes are of importance in that they constitute the great Clay Belt of northern Ontario. The early outlets of lake Ojibway are imperfectly known, but it is fairly certain that when the ice front occupied a position somewhat north of the present line of the transcontinental railroad, an outlet was found to the north and lake Ojibway came to an end. The deposits of lakes Ojibway and Barlow include an area of about 25,000 square miles of clay soil, varying up to about 50 feet in thickness. Along the southern shore of the lake the shallow water deposits are of coarser material, sand and gravel, which may be classed as forest land. The deeper water deposits were of clay, which accounts for the large area of potential agricultural land in this district.

Apart from the deposits of the glacial lakes there are also the deposits of morainic material, as well as glacial

river deposits which may be found almost anywhere in Ontario. These deposits are as a rule composed of sand and gravel, intermixed with boulders.

The two large areas in Ontario which have no glacial lake deposits include the Height of Land between Georgian bay and the Ottawa river, extending north to include a portion of the Timagami Provincial Forest, and a large area extending east from Rainy lake almost to the western end of lake Superior and from the International Boundary north, including the entire northern section of the province. Since the outlines of the glacial lakes are imperfectly known it does not appear justifiable to delimit these areas in more detail at the present time. These two areas are characterized by very thin deposits of soil of recent origin, interspersed with glacial deposits of morainic and fluvial materials.

Forest soil is classified usually as all land area which cannot be used economically for agricultural purposes. At the present time the areas of potential agricultural land in the north, chiefly in the Clay Belt, are forest covered and devoted to forestry purposes. But, as agricultural settlement advances, these will be cleared, particularly where large areas exist on which thriving agricultural communities may be established. Possibly at no time will all of the agricultural soils be utilized for that purpose, as there are scattered through the forest lands, areas, which, due to their small size and isolation from the general markets, will never, as far as now can be foreseen, support thriving agricultural communities. Forest soils, therefore, include, along with the light sandy, stony and thin rocky soils, areas of fertile soil which occupy occasional valleys between the Pre-Cambrian rock hills.

The nature of the underlying rock undoubtedly has a marked influence on soil accumulation. Much of the Pre-Cambrian rock is crystalline granite and gneiss which weather slowly and have remained for long periods on the upper slopes, supporting a very primitive vegetation of lichens and moss. On the granite hills, on very small areas there are found lichen-encrusted rocks, in the crevices and depressions of which soil has accumulated and trees have

obtained a foothold. Jack pine and red pine are common associates on these hills, with red cherry, red oak, white birch and aspen making up the hardwood content. These species frequently seed in profusely after fires on the upper slopes, but die very early from drought or are wind-thrown later, on account of insufficient anchorage in the thin soils. Softer rocks, occurring with the granite, weather more rapidly and the soil accumulations have permitted the growth of a more mesophytic association on the hill-tops. On the Loch Lomond watershed area, district of Thunder Bay, which is underlain by a comparatively soft rock, the hill-top association consists of white pine, white spruce, balsam, cedar, yellow birch, hard and soft maple, with poplar and white birch common in younger age classes.

Although the rock outcrops are more prominent on the hills and upper slopes, frequently the soil depth in the valleys is insufficient to completely cover the rock and exposures occur which have the characteristic hill-top vegetation.

The soil conditions over the province are characteristically diversified when small areas are considered, varying frequently in the distance of a few hundred feet from valleys with a fair soil depth to the moderate slopes and thin-soiled rocky hills. The repetition of these same features gives a general uniformity to the entire area where similar conditions of deposition have existed.

3 DRAINAGE

Another factor involved in the forest situation is the feature of drainage. The soil mantle is the reservoir in which water is held for the continuous use of vegetation. The texture of the soil, as also the amount of vegetable matter it contains, affects the water-holding capacity and determines the amount available in times of drought. The growth of trees with the large amount lost through transpiration during the growing season causes the withdrawal of large amounts of water from the soil. Excessive drainage, resulting in a lack of available water, especially during the height of the growing season, limits growth, even though all other conditions may be favourable. The effect of lack

of drainage contributing to an excess of free water in the soil is equally as adverse to good tree growth as excessive drainage.

The presence of an excess of water in the soil is usually due to an impermeable sub-stratum near the surface which raises the base water level to the region of the tree roots. It has been observed that swamps now too wet to permit anything but a scrub growth frequently contain logs and stumps of large size, the remnant of a much better forest growth than the area can now support. This indicates the raising of the level of the natural outlet by vegetable accumulation or the filling up of the outlet by other natural agencies, thus raising the base water level over the flat-lying area and reducing the forest growth to a scrubby type. A case of the more direct effect of the rise of the water level on the growth rate of trees was observed where a beaver-dam placed on a small creek caused the raising of the water level in a large black spruce swamp. The elevation was probably not more than a few inches, but this checked the growth rate, as was evidenced by the abrupt reduction in the width of the annual rings and in height growth, followed by resumption of usual growth rate twelve years later when the dam was broken away.

An excess of water in the soil interferes with aeration and such processes as nitrification in the soil. It also checks the decomposition of vegetable matter which accumulates as a thick peat layer over the mineral soil. The concentration of mineral and vegetable substances in relatively stagnant water under certain conditions makes the water unavailable for tree growth or may even give it a toxic reaction. A locality may be physically very wet, but if the water cannot be used the tree is in reality growing under very dry conditions. This contention is supported by the occurrence of such plants as labrador tea, which have the structural adaptations to dry localities, but grow in very wet bogs and muskegs.

The continuous expanse of interlacing roots in a forest covered area, as well as the absorptive nature of the humus layer, produced during the decay of the plant and tree

vegetation, increase the water-holding capacity of the soil, tending to retain the precipitation for the continuous use of the vegetation on the area. Experiments have shown that a layer of fallen leaves is capable of reducing evaporation of water from the soil by as much as 24 per cent. The forest canopy, through its control of the soil temperature in summer and protecting the ground, may reduce evaporation 61 per cent. The combined effect of a leaf litter and complete tree canopy has been noted to reduce evaporation by 85 per cent. Through the destruction of the forest cover by fire or logging a great deal of this advantage is lost. The water drains off more rapidly from the soil surface and the drying effect of direct sunlight reduces the available water. Plants that grew well under the forest cover are now in an unfavourable environment and fall off in numbers. The humus cover soon disappears and what was a moist growing situation under forest has become subject to severe droughts. On light sandy and thin rocky soils these effects are in some cases very marked. The area under forest cover supported a good growth, but, when opened up, the locality became drier until barren areas were produced which, subject to continued adverse influences, gradually extend their range, making conditions progressively less favourable for plant growth.

The general drainage conditions are related closely to the geological history of the province. The denudation during the advance of the last ice sheet removing the soil covering, and leaving the numerous rock basins free of soil, has contributed to the general "lakes-river" character of the forest area of the province. This condition was modified somewhat by the soil deposits laid down in the course of the retreat of the ice sheet. In the regions covered by the glacial lakes deposits were laid down anew in the depressions between the rock hills, lakes were not formed to such an extent along the drainage courses and many of the smaller depressions were filled with soil. The area assumed the character of a river country, although in the larger depressions lakes still existed. On the area not covered by glacial lakes there developed innumerable small lakes in the rock depressions. The rivers are frequently a series of lakes

with short stretches of fast water between where the drainage spills over the rock ledges. These characters are most pronounced in the Kenora and Rainy River districts. It also extends an unknown distance into Central Patricia. The eastern section of the province was largely modified by the glacial lake deposits, with relatively fewer small lakes and longer stretches of river.

The Coastal Plain is largely underlain by limestone of later age in contrast to the Pre-Cambrian formation. The limestone beds are almost horizontal with an average slope of about two feet per mile towards Hudson and James bays. The slope of the area is insufficient for cross drainage, so that the rivers and streams which flow generally in a northerly direction have few feeders from the side. The elevation of the area permits drainage only for a few hundred feet on each side of the drainage courses. The soils are thin, with the base water level near the surface; this has contributed to the formation of a thick layer of partly decomposed vegetable material, covered by a spongy layer of sphagnum moss. Only a narrow fringe of timber along the streams is found, generally merging into the extensive interior bogs and muskegs. The very important part which drainage plays in tree distribution and growth is shown clearly by the conditions in the Coastal Plain region.

4 FOREST FIRES

While the factors of climate and soil so far discussed are responsible for the general aspect of the forest, the original facies has been modified over large areas by fire, logging and other agencies.

Throughout Ontario, with the exception of swampy areas, there are probably few timber stands without their fire history.

The various species of forest trees differ widely in their susceptibility to fire damage. Hardwood stands, due to their less inflammable condition, have suffered less damage by fire. Old white and red pine stands resist fire well, as is

shown by the frequency of fire scars, while the thin-barked species, spruce, jack pine and balsam, usually succumb to very light fires. All coniferous species in the seedling stage are destroyed by very light fires. Damage in the form of fire-scars may permit the attack of wood-boring insects and fungus infection or, by the weakening of the tree, may permit the attacks of bark beetles which eventually kill the tree. Very frequently the growth rate of single trees or the entire stand is very much reduced by such damage.

The damage to the forest may also include injury to the soil, the soil humus or the soil life. Fires seriously disturb the balance of forest life, ground cover may be destroyed, or it may be stimulated and retard forest reproduction. The soil laid bare is susceptible to erosion, rapid run-off of water is favoured, liability of floods is increased. Finally, a series of fires may lead to the creating of barren areas, many examples of which exist in Ontario, which can never become forested except by planting.

The damage done by forest fires is reflected in the composition of the forest growth following fires. The existing vegetation is destroyed and usually, due either to the lack of seed or unfavourable habitat conditions set up by the fire, the original stand is not reproduced. On denuded areas tree species which have light, wind-distributed seeds, such as the aspen poplar, are favoured. Species such as white birch, which are capable of sprouting again from the live stumps, grow readily. Thus, following severe or repeated fires, these two species occupy a prominent position in the composition. Jack pine, because its seeds are retained for many years on the tree within a hard woody cone, which opens on the application of heat, also seeds in abundantly after fire and grows best on an open site. Spruce, white pine, red pine and balsam have not the seeding or establishment characters well adapted to the conditions set up by forest fires, consequently their numbers are lowered in the composition of the forest following a fire and where repeated fires have occurred they may be almost completely eliminated.

Table 2

Per Cent. of Number of Tress Per Acre

	Spruce	Balsam	Jack Pine	White Pine	Poplar	White Birch	No. of Trees per Acre	Age
1.....	1.8	1.1	60.0	..	14.9	22.2	694	53 yrs.
2.....	4.4	4.2	..	0.4	47.9	43.1	449	39 yrs.

1. Plot No. 8, Crooked Pine lake, Rainy River Forest Survey, 1927.
2. Type No. 57 Loch Lomond Watershed Forest Survey, 1928.

Due to the different intensities with which fire burns over an area, combined with the accidental occurrences of seeding in, survival and early growth conditions, the composition of the immature fire types is very variable. There are, however, two types of composition, illustrated in Table 2, which occur very frequently on fairly moist but well-drained sites. In one case the chief species is jack pine and in the second poplar and white birch. Since stands of these types have been observed in different stages of development throughout the province, a fairly safe prediction may be made as to their future development under natural conditions. Poplar is a tree of rapid growth and subject to attacks of tree diseases early in life. White birch is similar to poplar; it is slightly more tolerant, and reproduces readily by sprouts from the root crown. Jack pine is also relatively short-lived and very intolerant of shade. Both poplar and jack pine are incapable of growing and reproducing in much shade and therefore will not be present in the stands after their first rotation following the fire. White birch persists almost indefinitely in the stands, though much reduced in numbers. In fire stands, eighty years after their establishment, poplar, birch and jack pine are much reduced in numbers, their place being taken by spruce, white pine and balsam, which seed in and grow well in the moderate shade of the other species, gradually filling up the crown space as the shorter-lived species drop out. In some cases, where repeated fires have occurred on an area, the coniferous content, except jack pine, is so much lowered that it is not sufficient to fill up the stand as it opens up. Under such severe conditions the original forest

may not be established within a reasonable length of time without assistance by seeding or the planting of nursery stock.

The opinion prevails that forest fires have existed only since the early settlement of the country. Such a contention is well founded only in degree, as there is much evidence that extensive fires have occurred ever since forests existed. Thus fire may be considered as a natural influence until the era of extensive conflagrations which followed settlement and logging operations in the virgin stands. The fact that the great majority of the original stands of mature and over-mature timber were relatively even-aged indicates that the stands originated after a complete clearing of the area by some such agency as fire; the forest vegetation on a circumscribed area originating at one time as a unit and progressing to maturity under the natural laws of the survival of the species best adapted to the environmental conditions. The removal of the mature and decadent stands to-day by the lumberman's axe was accomplished formerly by fire, fungi and insects.

5 FOREST FUNGI AND INSECTS

Although the damage resulting from insect and fungus attacks in the forest is less spectacular than fire, over a period of years the damage caused is undoubtedly very great. Tree diseases, such as those caused by fungi, are responsible for a heavy cull in standing timber. Insect depredations, such as those due to the larch saw-fly, spruce budworm and hemlock looper, destroyed large areas of standing timber.

According to the investigations of the Dominion Entomological Branch, the spruce budworm is a native species, since periodic epidemics of this insect can be traced back for somewhat over one hundred years. Epidemics of this nature develop periodically and assume large proportions under conditions which favour them. The insects are subject to natural control, but develop in such great numbers that the natural control is not effective until the host tree species is destroyed, and frequently other species

of tree which the organism will not attack, except when present in great numbers. The larch saw-fly was introduced from Europe and was not subject to any natural control in this country. The native tamarack proved to be very favourable for the development and spread of the epidemic, which ran its course until practically all of the tamarack was killed. The introduction of foreign insects and tree diseases has created some of the most difficult problems in control, as native trees were found which were very susceptible to damage, and the natural control which was effective in the country from which the causal organism originated did not exist in the new home.

Fungus diseases and destructive forest insects, until the recent extensive outbreaks, received little attention, and no generalization can be made concerning the sum total of their influence on forest conditions. But the larch saw-fly epidemic of some thirty years ago affords an illustration of the damage they cause, since sufficient time has elapsed to observe the influence of this epidemic on the forest. Tamarack occupied a prominent position in the composition of a certain swamp type covering extensive areas, especially in the central and northern sections of the province. Many of these areas were practically pure tamarack, but black spruce and cedar were associated usually in varying proportions. The killing of the tamarack converted the swamps into pure black spruce and cedar. The former presence of tamarack in the swamps is evidenced by the standing dead spires and the fallen material. The result to-day is the existence of very large areas of black spruce swamp, whereas, without the insect and fungus attacks, black spruce at least in many cases, was of minor importance in the composition.

6 LOGGING

Among the external agencies influencing forest conditions may be included the various woods operations associated with the utilization of the timber resources.

In the development of the timber trade in Ontario the idea gradually evolved was to dispose of the merchantable timber, principally pine, for cash revenue before handing

over the land on which it grew to be converted into farms. The business was not regarded as a permanent industry. At first the system worked well, as many townships in the southern part of the province suited to agriculture were settled by this process. As the lumbering operations pressed farther north into the Pre-Cambrian area large areas were placed under license, the soil of which was unsuited for agriculture. The settler, however, continued to follow the lumberman, clearing the land and trying to make farms where the soil conditions indicated that only forests should be grown. Farms were cleared throughout the Ottawa-Huron region, which were in many instances abandoned after the transient lumber industry had removed the local market and the opportunity of winter employment to regions farther north.

The high grade timber standards of the early square timber operations left a great deal of inflammable material in the woods, with the resultant fire hazard. In the early part of the nineteenth century this started what proved to be almost a century of periodic forest conflagrations which have been checked only by an efficient system of forest protection. The fact that many of the old pineries have been burned over many times since the lumbering operations further involves the direct relationship of the present forest resource to the various regulations and practices under which the lumbering operations have from time to time been carried on. Up until 1892 licenses were granted for the cutting of all species of timber on the areas designated. At this time the policy was changed and subsequent licenses reserved spruce, cedar, hemlock, basswood and other woods to be disposed of otherwise by the Crown. It is doubtful if this regulation had any very far-reaching effect; white and red pine were the marketable species, and most of the other species were left at least for many years on the licensed areas.

Previous to 1870 the lumbering industry centred mainly in the Ottawa valley, but gradually shifted westward to the Georgian Bay district and in more recent years pressed northward into the Sudbury region. With the

opening up of the markets in western Canada the industry developed in the Rainy River region.

Pulpwood operations practically date from 1900, although pulp mills existed in the province from the early settlement days. The expansion of the pulp and paper industry led to the demand for spruce and balsam, species which had been treated hitherto as incidental or ignored altogether in connection with the white pine operations.

The hardwood industry, dependent on maple, beech, birch and poplar, has been localized up to the present time, due to the limited market and also to the difficulty in floating the logs, which adds to the cost of placing the material on the market.

The development of the jack pine tie and lumber operations is in response to the large increase of jack pine in the forest as a result of fire.

III. FOREST SURVEYS

The first general exploratory survey of the provincial resources was conducted in 1900, under the supervision of the Department of Crown Lands. Its purpose was to gather information concerning the region north of the Canadian Pacific railway, an area of some 60 million acres. The territory was divided into ten districts and one party detailed to examine each district. The main information sought was the general conditions as regards timber resources, agricultural possibilities and mineral chances.

For the material contained in this publication data from the surveys conducted by the Ontario Forestry Branch, by the Woods and Forests Branch, by private agencies and by the Dominion Topographical Surveys Branch have been used. These surveys total 73,457,000 acres, of which the Forestry Branch annual program has furnished two-thirds during the last decade. (See Table 3 for detailed statement of forest surveys.) The first survey by the Forestry Branch in 1920 marked the initiation of a definite plan of forest reconnaissance of the whole province, which is still in progress. While the information required by the Department relative to forest conditions has been

for varied purposes, from the first attention has been centred on mapping to show forest type and age class distribution, and information as regards the amount of standing merchantable timber. The earliest surveys, conducted in 1920 and 1921, were confined to the forest area south of the French and Mattawa rivers. The work was performed by ground parties and consisted of general type and age class mapping, controlled from roads, trails and canoe routes throughout the tract; no timber estimate was made.

About this time applications for pulp concessions greatly increased and, since the administrative policy provided for an inventory prior to sale, the demand arose for immediate information covering very large areas of timber land. The situation was met by the use of aircraft, from which type boundaries and geographic features were sketched prior to the examination on the ground by field parties. The practicability of the combined method was proved during the summer of 1921, when the Ontario Forestry Branch introduced aerial sketching to map a large area of the English river watershed in western Ontario. Flying for the operation was supplied by the Civil Operations Branch of the Dominion Air Board on a repayment basis.

The basis for the forest type classification throughout the reconnaissance surveys is the association of tree species occupying a given area at the present time. The unit areas segregated on this basis are called cover types and are used for classifying forest areas, both in aerial sketching and ground work and for maps and summaries of forest conditions. This classification along broad lines recognizes three types: the coniferous type, with 80 per cent of the number of trees conifers; the hardwood type with 80 per cent of the trees hardwood or broad-leaved; and the mixed type, including the intervening associations. Forest stands are further classified on the basis of age into mature, second growth and young growth. Mature stands are those which have attained commercial maturity. Second growth stands are those approaching maturity and vary in age from 25

years for fast-growing species on good sites to about 70 years for slow-growing species on poor sites. Young growth stands, like the second growth, vary in age up to 50 years, with maximum diameters not exceeding four inches breast high.

Field parties in possession of the aerial sketch maps can more efficiently plan the detailed examination of the forest types by detailing the major portion of the ground work to the more important timber types, and spending a minimum of time in recent burn, barren and muskeg areas. Chained lines or strips are run through the types at right angles to the general direction of the ridges. The data collected along the strips furnish the percentic samples for the composition of the types and the timber estimate; the present ages of the types are recorded; topographic features, such as heights of land and drainage courses, are noted, and the boundaries of the types are accurately established.

The accuracy of the results depend on how nearly the samples taken are the true average of the cover type being examined. Were there uniform conditions over a type where one acre did not vary from another one sample would be sufficient. This is never true, however, for within almost every square mile of timber are patches varying from blanks to many cords per acre. So, in estimating the quantity of timber, the amount of ground work depends on the average stand per acre and the size of the unit area to which the estimate is to be applied. In good timber are areas carrying from 0-40 cords per acre and, since the estimate to be accurate has to be the average of that range, more samples are taken. In a poorer stand the range might be from 0-8 cords. The range is shorter and fewer samples are necessary. The same principle applies in the area to be estimated. In a small type more acres per 100 have to be measured than in a large type.

IV. FOREST CONDITIONS BY REGIONS

From the results of the forest surveys eight forest regions have been recognized so far in Ontario. These regions are identified through the effect of the influence climate, soil and drainage have on the forest composition.

The Ottawa-Huron region and the Algoma Extension of it contain the tolerant hardwoods as the basis of the forest association. Hard maple and yellow birch are common over the whole area, but the associated species, beech, basswood and hemlock, commonly found below the French and Mattawa rivers in the Ottawa-Huron region, occur but in limited numbers in the belt along the north shore of lake Huron constituting the Algoma Extension.

The commercial distribution of white and red pine identifies two regions; the Sudbury region including the area between the Algoma Extension and the main Height of Land, and the Rainy River region, largely confined within the Rainy River district of western Ontario.

The remaining five regions in Ontario carry stands of more simple composition. White and red pine and the tolerant hardwoods are practically absent. The belt along the north shore of lake Superior, or the Lake Superior region, is spruce in mixture with the intolerant hardwoods. Jack pine and spruce in nearly equal proportions dominate the forests of the Central Divide region, lying north from the Sudbury region, also the Kenora Extension from lake Nipigon west to Manitoba between the Rainy River region and the approximate boundary of latitude 52 degrees. Spruce is the main species in the two northerly regions, the Clay Belt and the Coastal Plain, but physical conditions in the Coastal Plain are responsible for the occurrence of large areas incapable of producing commercial stands. Forest conditions in the Central Patricia region are not described.

1 OTTAWA-HURON REGION

This region, extending from the southern limit of the forest area of the province north to the French and Mattawa rivers, covers 11,626,000 acres, or 10 per cent of the provincial forest area. It was the scene of the earliest lumbering in Ontario, with the most active exploitation during the period 1860 to 1890. Only the best grades of white pine were removed, a great quantity in the form of square timber. The operations left the forest in a highly inflammable condition, both from the square timber operations and the

quantity of accumulated slash from the high quality lumber standards of that time. Fires followed and from the physical nature of the country left rock barrens in certain sections where the thinner soils had existed.

In the wake of the lumber industry agricultural settlement developed. While the lumber industry was thriving a local market existed for farm produce and, with winter employment in the industry, the settler was able to make a satisfactory living. At the present time, with the lumber industry much reduced in this region, the farmer is less able to eke out a living from these poor soils. Dr. Coleman, in a memorandum on the geology of the region, states: "The combination of kames (hills of sand and gravel with boulders) with pure sand deposits, through which rise occasional hills of the harder Archaean rocks, makes a region entirely unsuited for agriculture and useful only for forest growth. The result of glacial action north of the Palaeozoic rocks has been the formation of poor soils deficient in lime and often also in clayey constituents, except for the occasional limestone or shale and clay deposits." At the present time approximately two and one-half million acres are under some form of agricultural development.

In general the relief within the Ottawa-Huron region shows a greater range in elevation than is found in any other forest region in the province. At the outer edge of the region elevations are recorded of 380 feet above sea level for Pembroke, 475 feet for Tweed and 642 feet for Parry Sound. In the central portion of the region elevations along the Canadian National railway from Ottawa to Scotia Junction give 1,419 feet for Algonquin Park station and 1,607 feet for the summit just west of Brulé Lake. In this locality surrounding ridges and hills reach 1,600 to 1,700 feet. This higher country, centrally located, is the source of several of the important rivers in the region. From it originate the Petawawa river, the Amable du Fond river, the Madawaska river, the Mississippi river, the northern reaches of the Trent river and, on the west, the Muskoka and Magnetawan rivers.

While there cannot be implied that elevation is the controlling influence on the general forest association encountered in the Ottawa-Huron region it does serve to locate the associations or to describe the gradual changes in the composition of the forest from the higher to the lower levels.

Within the area of higher elevations the tolerant hardwoods, hard maple and yellow birch, predominate. Throughout the stand occur scattered white pine and occasional clumps of hemlock.

As the lower elevations are approached the forest composition gradually changes to one of a higher coniferous content, largely through an increase in white and red pine, spruce and balsam. Along the main line of the Canadian National railway from Ottawa to North Bay, east from Georgian bay and within the southern half of the Tweed forest district, white and red pine dominate the stands.

Local variations occur within the region and somewhat resemble the general transitions. Throughout this region, as the land rises from the swamps and water areas, pure coniferous stands are common, which in turn merge into mixed stands of hardwoods and conifers. Approaching the tops of the slopes mixed stands still prevail, but with changes in composition and merchantable value. On the uplands, where the soils are shallow, the pineries exist, but, where the soils are deep, the mixed hardwoods and conifers still extend.

Extreme swamp sites in the Ottawa-Huron region are chiefly composed of cedar, spruce, tamarack and balsam in various proportions. Where the water circulates more freely and soil conditions are less acid, black ash, yellow birch, soft maple and elm occupy the site. This latter is the common association in depressions within the mixed type.

Bordering swamps and lakes pure patchy stands of hemlock occur.

On the deep, loamy slopes hardwoods predominate. Hard maple, beech, basswood and yellow birch form the main stand, with white ash and black cherry occurring individually. Intermixed are white pine, hemlock and white

spruce. It is in these types that the best developed softwood trees, both in size and quality, are found. Farther up the slopes on the drier sites the yellow birch, beech and basswood give way to a more scrubby growth of hard maple, ironwood and red oak, with an increase in the white pine content.

Dependent on the soil depth and moisture the uplands are occupied by either of the two hardwood mixtures or by the pure pine stands.

The preceding is more a picture of the original forest, which, as a result of lumbering and fire ravages, occupies only a limited area of the region. The cedar and spruce have been largely removed from the swamps and the white pine and hemlock from the mixed hardwood and pure coniferous stands. As a result of fire fully two-thirds of the region is covered now by a temporary type, the poplar-birch association. Such stands, for the most part, have replaced former pineries and occur on the thinner soils.

In the poplar-birch stands, poplars and paper birch outnumber all other hardwoods and form the main crown cover, while in the understory various percentages of young pine, spruce and tolerant hardwoods are usually present. Hemlock is seldom found.

In the western and northern sections of the Ottawa-Huron region the natural restocking following fire is often jack pine. Extending east from Georgian bay in the Parry Sound district is an extensive plateau area of granite rocks with very thin soils. Pure jack pine stands of poor quality are common in this locality. Also on certain sand plains along the Ottawa river, jack pine again enters into the composition.

In the section of this report discussing the effect of logging, mention was made of the early regulations under which licenses were issued for the cutting of all species. About 1892 the policy was changed and licenses granted permitting the cutting of white and red pine only. Since red and white pine were the marketable species at this time, the hardwood-pine mixtures in this region have been converted into pure hardwood stands, and, under natural

conditions will probably remain so, due to the inability of the intolerant white and red pine to compete with the tolerant hardwoods, maple, beech and yellow birch.

As a result of the foregoing factors, to-day the forest type distribution in the region is 46 per cent hardwood and mixed combined and only 4 per cent coniferous; 50 per cent is covered by fire types, 37 per cent of which is poplar-birch, 2 per cent recent burn and the remaining 11 per cent is rock barren.

The forest age class distribution gives a better indication of the fire history. Twenty-two per cent of the forest area is classed as mature, 12 per cent as severely culled and the balance of 66 per cent is composed of: second growth 19 per cent, young growth 34 per cent, burn 2 per cent and barren 11 per cent.

What the future of this region will be is speculative. The most important species are white and red pine, hard maple and yellow birch. Yellow birch is probably the more valuable hardwood. While it is only observation it is backed by the experience of many lumbermen that yellow birch favours granite rock and hard maple limestone rock.

While forest surveys cover 10,216,000 acres, or practically the whole area, the class of survey was a general reconnaissance of conditions. No estimate of quantity of timber was made. In this region 3,400,000 acres are still held under timber licenses for the remaining pine, pulpwood and hardwoods.

(1a) ALGOMA EXTENSION

North of the Ottawa-Huron region there is a gradual dropping out of many of the hardwood species common farther south. Beech and basswood are conspicuous in this respect. Offsetting this reduction in hardwood species is the appearance of jack pine, a species of little commercial importance, south of the French and Mattawa rivers. This is the characteristic feature of the Algoma Extension.

The area included forms a belt north from the French and Mattawa rivers and the north channel of lake Huron for a distance of 30 to 50 miles. In the west, at Sault Ste.

Marie, it extends north some 100 miles to Michipicoten, between lake Superior and the Mississagi Provincial Forest. The total area comprises some 5,980,000 acres, or 5 per cent of the forest area of the province. Of this area 1,049,000 acres are settled or open for agricultural development, thus leaving a forest area of 4,931,000 acres. With the expansion of the lumber industry into this region and subsequent licensing of pulpwood limits there is at the present time 2,680,000 acres under license, or more than half the forest area. In addition almost 250,000 acres originally licensed have recently reverted to the Crown and are included in the Mississagi Provincial Forest.

In general the forest associations in that portion of the region north from Sault Ste. Marie, between lake Superior and the Mississagi Provincial Forest, show a distribution related to elevation resembling the conditions found in the Ottawa-Huron region. Species differ, but from the valleys to the ridge-tops there is the same domination of conifers in the lower levels and of the tolerant hardwoods on the ridges.

This topographic zoning of associations, however, is probably more distinct than is the case in the Ottawa-Huron region. In depressions and on the flat lands bordering streams are pure coniferous stands of spruce, mostly black. In well-drained valleys and on the lower slopes is a mixed coniferous stand, composed of white spruce and balsam, with a representation of black spruce, cedar, white pine and white birch. Farther up the slope the hardwood content increases by the occurrence of yellow birch and a mixed hardwood-softwood stand of white and yellow birch, white spruce, balsam and the occasional white pine extends to the margin of the pure hard maple stands on the upper slopes and ridges. Ledges, which often occur on the steep slopes, are usually occupied by white pine and cedar.

As in the Ottawa-Huron region the present condition of the forests in the Algoma Extension is the result of modifications through the influence of forest fires and lumbering; forest fires, many of which originated from mining activities, lumbering operations and railway construction have reduced large areas to an immature or barren condition.

The agricultural development is confined to the deposits from glacial lake Algonquin and a narrow border of clay soils a short distance back from the present Great Lakes shore-line laid down at the time of the Nipissing Great Lakes.

Largely due to the facts just mentioned there has been no industrial demand for information and no forest surveys have been conducted that would afford a basis for areal classification of the forest types and age classes.

However, from estimates made by private agencies, the following figures are submitted:—spruce (black and white), 6,395,000 cords; balsam, 2,460,000 cords; jack pine, 4,920,000 cords; white and red pine, 231,000,000 board feet, Doyle rule; hard maple and yellow birch combined, 421,780,000 board feet.

2 SUDBURY REGION

The Sudbury region is the centre of the white pine lumber industry in eastern Ontario at the present time. It occupies the area lying between the Algoma Extension of the Ottawa-Huron region and the main Height of Land separating the James bay and Great Lakes waters and lake Timiskaming and the Ottawa river. In this region 290,000 acres are settled or open for settlement, thus leaving 10,452,000 acres as the forest area.

Topographically the area is somewhat diversified, ranging from a rugged though not precipitous relief in the south to rolling country in the north at the southern limit of the Central Divide region. Elevations along the Canadian Pacific railway average about 1,300 feet above sea level, while along the southern boundary of the region 800 feet is the approximate average. This difference allows for a drop of at least five feet per mile and is sufficient to provide for excellent drainage throughout the tract. This feature is emphasized in that only 2 per cent of the area has been classed as muskeg.

The soils of the northern portion of the region have considerable gravel and sand deposits, corresponding to the beach levels of glacial lake Algonquin, while those in the southern contain a greater clay constituent with many

boulders intermixed. Thus in the Sudbury region the soils become finer from north to south, whereas in the territory to the north the soils become gradually finer until the Clay Belt is reached.

Corresponding to these variations of soil is the general distribution of tree species. The Timagami Provincial Forest probably illustrates forest conditions better than any other area of equal size within the region. Here much of the forest is in a virgin state and it is believed that the composition is more or less stable and further changes will be slow. Noticeably red pine occupies the extreme sites; on the thin, rocky soils, particularly around lake shores and rocky points jutting out into the lakes, it is found commonly in pure stands. As the soils improve white pine enters, forming a mixture, and further improvement permits additional competition from the hardwood species until, under the best growing conditions, the forest is a mixed hardwood-softwood one. White and occasionally yellow birch and maple are chief amongst the hardwoods, while white pine, white spruce and cedar constitute the conifers. It is with this association that white pine and white spruce reach their best development.

The red and white pine stands thin out towards the northern section of the region. This is probably due to the area being covered by coarser glacial deposits, creating drier sites, which have suffered more from fire and now carry jack pine with varying percentages of black and white spruce in mixture.

Throughout the Sudbury region the general swamp types are pure black spruce stands, with sphagnum moss as the ground vegetation under acid conditions; and with improved drainage cedar and black spruce mixtures form the stand.

In parts of the Mississagi Provincial Forest white pine was found to be in the neighbourhood of 350 years of age and carrying two fire scars, one about 150 years ago and the first one about 250 years ago. These are the oldest fires recorded in the district. However, fires have occurred periodically up to the present time, giving rise to series of

age classes, thus providing an opportunity for seeing the development of stands from youth to maturity. The character of the reproduction that follows a forest fire is determined by many factors. Some of these factors are the composition and age of the original stand, whether the fire occurred in a seed year, the severity of the fire and the position of the burned area in relation to the adjacent stands. Forests which originate under such circumstances are naturally of a varied character, but the variable is usually the extent to which one species occupies a situation.

In the Sudbury region there are two common methods of reproducing an area after fire. In one instance aspen poplar and white birch appear to dominate the area for a period. Soon, however, spruce and balsam in varying numbers appear as an understory. The other common method is jack pine reproduction and, like the poplar-birch, has its spruce understory. As both types become older the poplar in the first case and the jack pine in the second gradually drop out of the composition. Balsam becomes more abundant with the increased age of the stand, but seldom enters into the main crown cover.

In those cases where white and red pine constitute the reproduction following fire there appears to be a close connection between the composition of the original stand, the severity of the fire and, to a lesser degree, the date of a white pine seed year following the fire. White and red pine are species resistant to fire, and many examples are to be seen where they have escaped to serve as seed trees and have reproduced the original stand.

Of the 10,452,000 acres constituting the forest area of the Sudbury region, 6,983,000 acres have been examined during the forest surveys so far conducted. This represents two-thirds of the forest area of the region and includes the Mississagi Provincial Forest, a western section of the Timagami Provincial Forest and sections of the intervening country.

Forest type classification in the Sudbury region places 45 per cent of the total area as mixed stands, 38 per cent as coniferous, 5 per cent as recent burn, 2 per cent as muskeg

or barren and 10 per cent water. As is to be expected the southern half of the region has a slightly higher percentage of mixed stands than the northern. Ridges are lower along the Height of Land and sand plains and esker formations are more common. In addition, yellow birch and hard maple are present in the southern section to a limited extent and help to increase the hardwood content.

The age class distribution for the forested area, i.e., excluding water, shows 58 per cent of the area mature, 14 per cent second growth, 21 per cent young growth, 5 per cent recent burn and 2 per cent muskeg or barren. In preponderance of mature stands this region is exceeded only in the case of the Nipigon Extension of the Clay Belt, where 72 per cent of the forested area is classified as mature.

The timber estimate for the Sudbury region bears out the remarks previously made as to its importance in the lumber industry. White and red pine combined are estimated at 5,855,000,000 board feet, Doyle rule. In addition there are 11,921,000 cords of spruce, 4,699,000 cords of balsam and 11,291,000 cords of jack pine. In the Sudbury region approximately 80 per cent of the combined estimate for white and red pine is white pine, while in the Rainy River region the ratio is more nearly half and half. There is also an interesting comparison as to quality in the two regions. Lumbermen who are familiar with both regions claim white pine to be more defective in the east than in the west, but this is offset by a greater height growth and a higher quality value.

At the present time 74 per cent of the Sudbury region is held under lumber and pulpwood licenses, 70 per cent pulpwood licenses and 30 per cent lumber licenses. This statement somewhat over-emphasizes the area under pulpwood license, for within the latter white and red pine, jack pine over ten inches and large spruce are reserved to the Crown.

3 RAINY RIVER REGION

The Rainy River region occupies a geographic position in the western part of the province similar to that of the

Sudbury region in the eastern section. The forests of the two regions probably have a common origin south of the Great Lakes system, dating from the glacial period. The plant migrations, on the retreat of the ice sheet, were affected, no doubt, by the barrier afforded by the Great Lakes, the Sudbury region possibly receiving a direct northward migration, while in the case of the Rainy River region migration probably occurred around the south of lake Michigan and lake Superior. The two floras have developed in many respects along divergent lines, retaining similarities in tree species and composition derived from their common origin.

The Rainy River region occupies a total area of 8,415,000 acres, extending from the Manitoba boundary south of lake of the Woods to lake Superior. It includes the drainage basin of Rainy lake in the west and a portion of the drainage areas of the Pigeon and Kaministikwia rivers flowing into lake Superior. The existence of glacial lake Agassiz, covering a portion of the western section, and of glacial lake Algonquin in the Fort William district, accounts for 1,356,000 acres of land at present under agricultural development. The areas of agricultural land consist of clay deposits of considerable depth, which are in marked contrast to the rough forest land. Of the total area comprising 7,059,000 acres devoted to forestry purposes, 4,069,000 acres have been examined in the forest survey program.

In its general aspect the region is typical of the Pre-Cambrian formation in Ontario. The denudation by the advance of the ice sheet is more marked in this region, since on its retreat soil deposits were not laid down in glacial lakes as was general in the eastern section of the province. The soil deposits on the forest area are, therefore, limited to the glacial moraine and river deposits and the more recent accumulations of vegetable matter. The depressions in the rock hills are occupied by innumerable small lakes, which, along with the broken, rough rivers, represent the extreme "lakes-river" character of the Pre-Cambrian area.

The Rainy River region has an average frost-free period of 93 days, which is second only to the Ottawa-Huron

region in length of growing season. The mean annual precipitation is 23.74 inches, with 12.44 inches during the growing season, June 1st to October 1st. Compared with the Sudbury region, which has a mean annual rainfall of 28.46 inches, with 10.97 inches during the four summer months, a considerable difference is to be noted in the seasonal distribution of the precipitation. In the west there is comparatively light snowfall, with a large proportion of the total precipitation during the growing season. The snow, therefore, leaves the ground earlier in the spring, which may account in part for the longer frost-free period in the Rainy River region.

Forest associations resemble those of the Sudbury region in that the original stands of timber in this region contained a high percentage of red and white pine, much of which has been cut off and subsequent fires have burned over a large proportion of the area. Related possibly to the difference in soil and climatic conditions are some changes in the forest composition. Red pine almost equals white pine in the association, tolerant hardwoods are almost entirely absent in the Rainy River region and the trees generally have a shorter maximum height growth than is usual in the eastern section of the province.

The present forest type classification allots 42 per cent of the forested area to the coniferous type, 20 per cent is mixed, 36 per cent recent burn, 2 per cent muskeg and barrens; excluding Rainy lake and lake of the Woods, 19 per cent of the total area is water. The age class distribution shows the modified condition of the forest area as 17 per cent mature, 17 per cent second growth, 28 per cent young growth, 36 per cent recent burn, and the remaining 2 per cent barrens and muskeg.

Forest fires have played an important part in the development of the present condition of the forests in this region, as is indicated by the large percentage classified as recent burn. As has been pointed out previously the general soil covering is thin, and on the hill-tops is composed largely of vegetable matter. On the slopes there is, as a rule, a scanty accumulation, with soil of fair depth only in the

valleys. Forest fires consume a large proportion of the soils of vegetable origin on the hill-tops and steep slopes. The remaining mineral constituent of the soil is soon washed away into the valleys, leaving many of the hills almost bare rock. Under such conditions there is a long period following fire when regeneration does not take place and the area remains barren until sufficient time has elapsed for the tree vegetation to gradually extend from the valleys to the severe growing conditions on the higher slopes. All areas of this nature are included in the "recent burn" classification.

Within the past sixty years 81 per cent of the total area has suffered from forest fires, the most extensive of which centred around the years 1872, 1895, 1910 and 1923. From available data probably 800,000 acres were burned over within a few years centred around each period. Fires undoubtedly occurred between these periods, but, from data obtainable, they were of small extent compared with the larger periodic conflagrations. These periods of extensive forest fires coincided with periods of important industrial development of the region. The first period was that of the mining development, the second period was associated with railroad construction and the last two periods probably more closely related to the development of the logging industry. Judging from the last fire period possibly the years of extensive fires coincided with very dry weather, which, along with the conditions accompanying the industrial development, favoured the very high fire loss, confined largely to a relatively short period. The subject of forest fires has not been investigated thoroughly from this standpoint, but from data available it appears that there is a definite relationship between the industrial development of an area, the broad climatic cycles of wet and dry periods and extensive forest conflagrations.

The present forest cover of the region reflects the relation between the fire history and the soil conditions. The conditions following fire favoured other species, largely to the disadvantage of red and white pine. Jack pine is the species best adapted to the damaged thin soils, while poplar and birch seed in profusely where there is a fair covering of

soil. The re-establishment of a complete canopy and a soil covering is a slow process, and treeless areas have, in many cases, a tendency to extend their boundaries rather than to fill up. The part which forest fires have played in the deterioration of the site quality is one of major importance in the Rainy River region. Over the area in general red and white pine have not reproduced where they originally grew, and the long process of building up the site factors so that the area will again be favourable to these species appears to be one of the controlling influences in the re-establishment of white and red pine stands in this region.

The timber estimate for this region does not in any way represent the relative potential value of the land to produce forest products. Repeated fires are responsible for this condition, and many areas once forested have reverted to brush lands on which timber species have not established themselves. The estimate gives 6,964,000 cords of spruce, 609,500 cords of balsam and 7,194,000 cords of jack pine. In addition to this the present stands of white and red pine are estimated to yield 928,274,000 board feet, Doyle rule, of lumber. The estimate of jack pine is slightly greater than that of spruce, which is a reflection of the fire history rather than an indication of the potential value of the region in general. The virgin, or uncut, white and red pine stands are largely confined to Quetico Provincial Park, although large commercial stands covered most of the region originally.

The original stands of pine in the Rainy River region contained almost as much red pine as white pine. The thin, rocky soils in the Rainy River region afford the explanation to this as red pine is not as exacting as white pine in regard to soil requirements. While red pine grows on the thin soils it produces an inferior grade of timber of small size. Depending largely on the site on which it grows, three grades of red pine have been recognized locally, "Timber Norway," growing on deep soils and producing high-grade lumber, "Common," growing on thin, rocky soils, where it attains a much smaller size, and "Pig-iron Norway," produced on the rocky ridges, where it grows slowly, attains a

diameter of about ten inches and produces a hard, brittle product, not much superior to jack pine.

Logging in the Rainy River region practically dates from 1900, with the opening up of the markets following the development of the prairie provinces to the west. The industry, based on red and white pine, has flourished since that time. More recently a large pulpwood industry has been established in the region, with several smaller plants manufacturing mainly jack pine ties and lumber. The industries based on the forest resources, except possibly those utilizing jack pine, will, without management of the forest resources, be placed on a declining scale.

4 LAKE SUPERIOR REGION

Along the north shore of lake Superior an area of rough, rocky country extends in a belt about 100 miles wide, westward from Michipicoten harbour to the south end of lake Nipigon, and as a much narrower strip to the city of Fort William. Physiographically this area is similar to its continuation on the east shore of lake Superior and included in the Algoma Extension of the Ottawa-Huron region. The delimitation as a separate region is based upon the small part played by red and white pine and maple and yellow birch in the composition of the forests. In contrast to the Central Divide region the Lake Superior region is a spruce country rather than having jack pine the dominant species in the composition.

The soil and drainage conditions are those characteristic of the Pre-Cambrian in Ontario, but the country is more rugged and rocky than is usual throughout this formation. The highest point in the province, Tip-Top Hill, 2,120 feet above sea-level, is located in this region. Although the region lies adjacent to lake Superior, with an elevation of 602 feet above sea-level, it rises rapidly to a general elevation of around 1,200 feet a relatively short distance north from the lake. It is probable that elevation, through its effect on climate, is one of the primary factors responsible for the forest conditions of the Lake Superior region.

Due to the remote nature of the country, generally representative meteorological data are not available for this region. The average length of growing season, 67 days, is derived from three stations, two of which are adjacent to lake Superior. The third station, White River, located at an elevation of 1,223 feet, is near the average elevation for the region, and has a frost-free period of only 37 days. It is, therefore, probable that the length of growing season in the Lake Superior region is as short as in any part of the province, giving rise to the more northerly type of forest cover.

The total area of the Lake Superior region is 6,272,000 acres, 316,000 acres of which are open for agricultural settlement, leaving a total forest area of 5,956,000 acres. Information available on forest type distribution and age class conditions is confined to a small portion of the Nipigon Forest Survey and Pic, Pagwachuan and White Otter River Forest Survey. The small amount of data available cannot be considered as representative of the whole region.

On 2,131,600 acres timber estimates are available which have been used as a basis for an estimate for the whole region. This is placed at 8,079,600 cords of spruce, 952,700 cords of balsam and 994,600 cords of jack pine. The predominating species is black spruce, with a small association of white spruce, confined chiefly to a narrow strip along the drainage courses. Jack pine is common in some sections, especially along lake Superior and in the western section of the region, where it has established itself on burned areas. Balsam is found generally scattered through the spruce stands, forming about 10 per cent of the composition. The hardwood species are poplar and white birch, which are common in all the younger age classes.

The development of this region commenced at an early date, with the construction of the Canadian Pacific railroad along the north shore of lake Superior. Owing to the rough nature of the region and difficult means of transportation, the development of the area has been confined to the western part in the vicinity west of Nipigon where lands have been taken up for agriculture and the forest area modified by fire.

To the north and east of the region the forests are, for the most part, in a virgin state.

Of the total forest area of 5,956,000 acres, 322,000 acres are held under timber license and 4,821,000 acres included in pulpwood concessions. Practically the entire forest resource of this region is at the present time under license, which forms an important part of the pulpwood supply of several large pulp and paper mills.

5 CENTRAL DIVIDE REGION

The Central Divide region is mapped as extending from the Ontario-Quebec boundary in the east to lake Nipigon in the west. It is centrally located in the province and occupies the southern third of the 300-mile slope from the Height of Land to James bay. In the west the Albany river is arbitrarily chosen as the northern boundary, due to insufficient information permitting its extension further.

This region comprises 22,871,000 acres, or 19 per cent of the total forest area. Of this total, 9,095,000 acres have come under examination by the different forest surveys and serve as a reliable basis on which to discuss the features of the region.

The general relief of the tract is rolling. Ridges are low and there are few outstanding elevations. Drainage is good. It is a river country, with lakes occupying the river expansions. The water area represents 10 per cent of the total area.

Fairly deep, coarse, sandy and gravelly soils characterize the whole area. However, in the northern section, as the country flattens approaching the Clay Belt, more clay is found. This feature is related to the deposits from glacial lake Ojibway. In the southern part of the lake the coarser materials were laid down, but, farther north, into what at the time were the deeper waters of the lake, the deposits consisted of finer material until the real clays are reached in the Clay Belt.

The forest composition in the region is simple. Tree species are black and white spruce, jack pine, poplar and

white birch. White and red pine occur in scattered patches, seldom in a concentrated quantity sufficient to warrant a separate operation.

Forest fires have influenced the present composition of the forests in this region. Commonly, after a fire, well-drained areas restock with poplar and birch or with jack pine, and in almost every instance with a scarcely noticeable understory of black spruce. Jack pine and poplar are comparatively short lived species; both are subject to fungus diseases and, after 70 years, become weakened and drop out of the composition. Hence, when stands of timber have reached 150 or more years of age, the composition is largely black and white spruce, balsam, white birch and occasionally scattered white pine. This is the usual development of stands in this region and, even though two areas might begin, one with poplar, birch and spruce, and the other jack pine and spruce, with scattered hardwoods, there comes a time later when they resemble each other.

The forest types of this region are either mixed or coniferous, 58 per cent of the forested area being mixed and 29 per cent coniferous. (2,161,000 acres not classified into forest types.)

The age class classification for both types shows 53 per cent of the forested area in this region as mature, 16 per cent is second growth and 20 per cent is young growth. The remaining 11 per cent consists of 5 per cent recent burn or young growth unclassified and 6 per cent muskeg and barren.

An actual estimate of the timber on 8,465,000 acres in this region has been made. On the assumption that the balance of the section is similar, there is a total of 51,576,500 cords of spruce, 7,311,000 cords of balsam and 26,463,000 cords of jack pine. Percentically spruce furnishes 60 per cent, balsam 9 per cent and jack pine 31 per cent of the total quantity.

At the present time there is no agricultural development in this region, thus leaving the total area as forest land. On the other hand 40 per cent, or 9,478,000 acres, is held under license, 78 per cent being for pulpwood and 22 per cent for lumber.

(5a) KENORA EXTENSION

The spruce-jack pine forest continues west and north from lake Nipigon and is considered as an extension of the Central Divide region. Though the forest cover in the two areas show similarities, soil depth and physical characters of this section are different.

From south to north in the Kenora Extension there is an apparent decrease in the soil depth, until north from the English river the country is classed as 43 per cent rock-barren and muskeg. It is doubtful whether this barren condition is natural or due to repeated fires. However, it is believed that thinner deposits were laid down here in glacial times than was the case farther east.

The drainage feature of the Kenora Extension provides a striking contrast to other parts of the province. The surface water area is 23 per cent of the total and this is exclusive of lake of the Woods, lac Seul and lake St. Joseph. In the Central Divide region the water surface is 10 per cent. The high percentage of water is one of the characteristics of the Kenora Extension. Largely due to the thinner soils and the fact that but a small area in the western part of the district was subject to the surface-levelling action of water, the country was left more dissected, with lakes occupying the depressions. It is characteristically a lake country, the water from one lake spilling through a short stretch of river into the next.

The Kenora Extension is the largest of the forest regions, totalling 33,750,000 acres, or 29 per cent of the total forest area; as more information is gathered there is a probability that the northern boundary may be extended. As the area is now mapped it extends north from the Rainy river watershed to a line roughly corresponding to latitude 52 degrees.

In all 19,102,000 acres have come under forest type and age class examination, the great part of which is included in the Dominion photographic survey, which delimits the boundaries of water, timber, barren and muskeg and reproduction.

The classification of the forest into age classes shows 38 per cent mature, 7 per cent second growth, 20 per cent young growth, 1 per cent recent burn and the balance 34 per cent barren and muskeg. One feature of the age classes is that they individually cover large areas, so that the general appearance of the country is not "patchy."

From the above figures it is to be noted that at the present time only 38 per cent of the forest area is mature, and that 62 per cent has been burned within the past 50 years and so badly that over half of the burn is now in a barren state. Contributing to this condition is the lower mean annual precipitation of 25.6 inches, thinner soils and the general northeasterly-southwesterly direction of the topography or the same direction as the common course of forest fires. Under such circumstances the forests are in a more hazardous position in regard to fire.

The timber estimate is based on reports covering 20,230,000 acres, almost two-thirds of the total, and the whole tract is estimated to contain 43,679,000 cords of spruce, 4,363,000 cords of balsam and 26,685,000 cords of jack pine. Over the forested area the average yield is 2.9 cords per acre, and per mature timbered acre 6 cords. In connection with the estimate the higher percentage of jack pine in the Kenora Extension, namely 36 per cent as compared with 31 per cent in the Central Divide, further emphasizes the drier sites characteristic of western Ontario.

Land in this region, settled or open for agricultural development, amounts to 556,000 acres. This area, like that in the Rainy River region, is largely the clay deposits from glacial lake Agassiz, near Dryden on the Canadian Pacific railway.

The area licensed for pulpwood and lumber is 8,240,000 acres, 7,115,000 acres being under pulpwood license and 1,125,000 acres under lumber license.

6 CLAY BELT REGION

The Clay Belt region corresponds with the deep water deposits of glacial lakes Ojibway and Barlow. These deposits cover an area of 17,000,000 acres; 16,000,000 acres

of deposits in lake Ojibway, being located centrally in eastern Ontario on the slope from the Height of Land to James bay; and 1,000,000 acres of deposits in lake Barlow, in the Timiskaming basin, which drains through the Ottawa river to the St. Lawrence. As its name implies, the Clay Belt region generally is potential agricultural land, composed of fertile clay soils of varying depths. Up to the present time agricultural settlement has been localized along the railroads, with most of the interior lands devoted to forestry purposes.

The surface of the area is an undulating plain, the shallow depressions mostly occupied by swamp or peat bog. In places rock ridges rise above the plain, but for the most part the clay is thick enough to conceal the bedrock. The distribution of the clay is governed by the extent of land covered by the lakes, the amount of sediment carried into them and the subsequent drainage which reduced the water area or drained the lakes and made their sediment available land surface. The largest area of stratified, stoneless clay is found in the Timiskaming basin and in the southern parts of the northern Clay Belt. These deposits are characterized by alternate layers of grey clay and fine-grained calcareous silts. Beginning somewhat south of the line of the Canadian National transcontinental railway and extending north into the Coastal Plain region the soil consists of highly calcareous, plastic boulder clay, carrying a great deal of fine rock particles along with the pebbles and boulders. There are, however, patches of pure stratified clay in depressions on the boulder clay surface.

Apart from the two main drainages afforded by the Height of Land between Hudson bay and the St. Lawrence drainage systems the drainage is fairly uniform. In contrast to the Pre-Cambrian area, lakes are relatively few in number and frequently shallow, with low, clay shore-lines. The rivers have long stretches of sluggish waters and few lakes along their courses. The waters of the rivers are frequently muddy, due to the large amount of fine clay materials which are collected and carried in the absence of broad lake expansions along the river courses. The low, undulating plain

character of the surface, together with the high water-holding capacity of the clay soil, contributes to the formation of bogs and muskegs in all of the depressions. The vertical elevation in many sections does not permit of adequate cross drainage, so that feeders draining into the main river channels are comparatively few.

The special character of soil and drainage is reflected in the species of tree and in the development of the stands. With but a slight rise in the general level of the land, the forest composition changes from a pure spruce forest to a mixture of aspen poplar, white birch, black and white spruce and balsam fir. The chief tree species is black spruce, which constitutes about two-thirds of the forest composition; balsam fir accounts for about one-sixth; aspen and white birch are common associates in the immature stands and occur with white spruce along the drainage courses and around lakes. Jack pine occurs in a few localities on patches of light soil, but finds unfavourable conditions in the deep clay soils of the Clay Belt region. White and red pine are known to occur only in isolated patches.

Of the forested area 35 per cent is classified as coniferous and 20 per cent mixed; recent burn covers 25 per cent, barrens and muskeg 20 per cent and water 5 per cent.

Until the recent agricultural development of sections of the region, forest fires were relatively few, and the establishment of the present stands has, in many cases, followed the gradual deterioration of old stands without the complete clearing of the country by such agencies as forest fires. This has contributed to the establishment of such tolerant species as black spruce and balsam fir. Considering the land area, 47 per cent is covered with mature stands, 3 per cent second growth, 9 per cent young growth, 24 per cent recent burn and 17 per cent barren and muskeg. The large area classified as mature, with the relatively small area of 12 per cent immature, shows the natural condition of the forests before the recent agricultural development. The high figure of 24 per cent recent burn is an expression of the effect of the recent development of agriculture and logging. The area of 17 per cent classified as barrens and

muskeg is almost wholly made up of situations too wet to support tree growth. (815,000 acres not classified into forest types.)

Of the total 16,928,000 acres comprising the Clay Belt region, 2,361,700 acres are at present under agricultural development. This leaves a total forest area of 14,566,000 acres. Of this forest area definite information is available for 6,312,584 acres, or slightly less than one-half. The estimate for the region, based on the portion surveyed, is 44,028,000 cords of spruce pulpwood, 4,655,600 cords of balsam and 906,000 cords of jack pine. In addition to this there is a small cordage of aspen and white birch, which are the only common hardwood species.

Of the forest area of 14,566,500 acres, 708,500 acres are under timber license, and 6,937,000 acres under pulpwood license, making a total of 7,645,500 acres, or slightly over one-half of the total forest area. Three large pulp and paper mills and several smaller plants are dependent for their raw materials on the forest resources of the Clay Belt region.

(6a) NIPIGON EXTENSION

The Nipigon Extension consists of deposits laid down in glacial lake Algonquin. The Algonquin clay areas are not very extensive and occur in isolated patches, as a rule in low land, with a margin of rock ridges. Two such areas form the Nipigon Extension of the Clay Belt region. The Algonquin clays are stratified and mostly of a reddish colour. They contain less silt and a smaller percentage of lime than the Ojibway clay and are frequently stoneless. The surface and drainage features are very similar to the northern Clay Belt region, as well as the mode of deposition of the clay soils.

The chief tree species is black spruce, with balsam and jack pine as minor species in the forest composition; aspen and white birch occur in the younger stands and associated with white spruce along the drainage courses. White and red pine are represented only as a few scattered patches.

The total forest area includes 1,753,700 acres, for 1,208,000 acres of which data is available from forest

surveys. Of the total forest area, 45 per cent is occupied by the coniferous type, 36 per cent mixed type, 2 per cent recent burn, 7 per cent barren and muskeg and 10 per cent water. The larger proportion of water is made up of two large lakes in the region. The classification of the forest into age classes shows 72 per cent mature, 3 per cent second growth, 16 per cent young growth, 2 per cent recent burn and 7 per cent muskeg and barren. The relatively small figure of 2 per cent for recent burn is due to the lack of industrial development in recent years. None of the area at present is open for agricultural development.

The estimate of timber for this region gives 7,913,000 cords of spruce, 730,000 cords of balsam and 637,000 cords of jack pine. In addition there is a small amount of poplar and white birch.

Of the total forest area of 1,753,700 acres, 1,522,560 acres are under pulpwood license and 10,240 acres are under timber license, making a total of 1,532,800 acres, or almost the entire forest area. Up to the present time little cutting has been carried on in this region, although the pulpwood resource is a prominent feature in the reserve supply of a large pulp and paper mill recently established.

7 COASTAL PLAIN REGION

The Coastal Plain includes a belt of limestone and shale of Palaeozoic age encircling James and Hudson bays. When the ice sheet receded from the region around James bay the land appears to have stood about 300 feet lower than at present and seawater replaced the ice on the northward slope of the region. Marine sedimentation was active at that time and a considerable amount of massive, calcareous, mostly stoneless clay was laid down. Later, with elevation of the region, these clays became the surface of a great part of the Coastal Plain region, extending inland for nearly 100 miles from James bay. A great deal of the marine clay has been carried away by subsequent stream erosion. Available information on the deposits of this remote region is confined to the main river courses and travel routes.

The total area of the Coastal Plain region is 59,553,000 acres. Of this area 5,998,000 acres have been covered by forest surveys, comprising the area south of James bay from the Mattagami river to the Quebec boundary and an area on the Opasatika river. The country north and west of the Missinaibi river has not been explored and very little is known of this section of the region. The lands are flat-lying and poorly drained. The average slope towards James bay is about 2 feet per mile, which does not permit adequate cross drainage, the rivers flowing in a northerly direction, having few feeders from the side. This parallel drainage system, without the usual network of small streams, has contributed to the formation of large areas of bogs and muskegs between the drainage courses. This condition is further attributed to the flat-lying limestone beds and the layer of clay soils which bring the base water-level near the surface. The vertical elevation of the land along the water courses is usually under 30 feet, which in many cases lowers the base water-level for one-quarter mile back on each side of the stream and thus permits good tree growth on this strip. Very frequently the vertical elevation is 10 feet or less, which is only effective for a few hundred feet. Hence, only along the drainage courses, around lakes and on elevated land are commercial stands of pulpwood species found.

Of the total area only 7 per cent bears merchantable stands of timber, while 73 per cent is muskeg, bogs and natural barrens, with 20 per cent recent burn. The composition of the forests on the better sites is similar to the Clay Belt region, black spruce being the common species. White spruce of large size, along with balsam, poplar and white birch, occupy a prominent position in the stands adjacent to lakes and streams. Jack pine is occasionally found associated with the other species on well-drained sites. Tamarack and cedar do not develop to commercial size, but are common associates in the muskeg type.

Beyond the fringes of timber the country contains vast areas of bogs and muskegs, interspersed occasionally with small hummocks and ridges rising above the plain and on

which stands of timber of pulpwood size are found. The bogs and muskegs usually show a thick layer of partially decomposed vegetable matter, with a spongy layer of sphagnum moss on top. During most of the season free water is found in all of the small depressions in the moss covering. The physical condition of the swamps contributes to the retention of a frozen condition during a large part of the growing season. The heavy frosts of winter freeze the bogs and muskegs, while, in the summer, thawing out is retarded by the insulating effect of the water and moss covering. Bogs and muskegs, therefore, remain frozen at a depth of a few feet late into the growing season. The condition is one rather of physical properties of the ground cover than of climate of the region and therefore is not confined in its application to the Coastal Plain region.

The plant growth on these muskeg areas presents some special adaptations. Black spruce and tamarack are the only tree species able to survive, but, of course, as a very stunted growth. Only occasionally is a black spruce seedling able to establish itself and then only to grow at an extremely slow rate, with long lower branches spreading over the ground cover. The sphagnum moss builds up around these lower branches which take root and grow, producing in time a separate tree. This layering process continues, gradually developing into a thick, circular clump of scrub growth, the tallest trees in the centre of the clump and the recent layering growth at the outside giving a roughly cone-shaped outline. The muskegs of the Coastal Plain region present a very characteristic appearance, due to these many scattered clumps. Cedar has, in many instances, been observed behaving similarly to the scrub black spruce. The tamarack seldom exceeds three feet in height and if taller has a dead top, with a few living branches growing and occasionally taking the form of a leader half way up the trunk. The leaders die progressively, giving older trees an odd, forked appearance. The growth of boths pruce and tamarack seedlings is fairly rapid until they are about 3 feet high, when both diameter and height growth begin to fall off. After a height of 10 feet and a diameter of 2 inches is attained the growth rate becomes almost imperceptible, trees under 4

inches frequently being over 150 years of age. The maximum heights and diameters attained by trees growing in these muskegs are very variable, depending on drainage conditions and the ability of the roots to reach the mineral soil. While growth is so slow, it frequently persists until trees over 6 inches in diameter are produced.*

Industrial development has not progressed into the Coastal Plain region. The small amount of pulpwood with undeveloped transportation facilities probably will not attract industry based on this resource. An estimate of timber is not included, as the entire area is at the present time inaccessible to markets and, without the opening up of the country for some other resource, the existing forests will remain probably in their untouched present state.

8 CENTRAL PATRICIA REGION

The Coastal Plain region is well defined by the general boundary of the Palaeozoic rocks back from the shores of James and Hudson bays. It is known that it is justifiable to extend the northern boundary of the Kenora Extension to at least latitude 52 degrees. Intervening is an area of slightly over 40 million acres which has been called the Central Patricia region, but very little is known regarding the forest growth.

V. SUMMARY OF FOREST CONDITIONS AND RESOURCES

Area

The total area of the province, exclusive of southern agricultural Ontario is 221 million acres. The major divisions of this area, which are given in detail (Table 4), include 100 million acres in the inaccessible and little known regions of Central Patricia and the Coastal Plain. Excluding these two areas and 3 million acres covered by the larger bodies of water, there remains approximately 118 million acres as the forest area at present known and accessible. Within this area 8 million acres are at present under agricultural development, leaving a total forest area of 110 million acres.

*James Bay Forest Survey, Department of Lands and Forests, Forestry Branch, Toronto, Ontario, 1922.

Timber Estimate

The timber resources are summarized in Table 5. On an area of slightly over 100 million acres there are estimated to be 180,558,000 cords of spruce, 25,781,000 cords of balsam and 79,090,000 cords of jack pine, making a total estimated yield of 285,429,000 cords of pulpwood. The estimate is based on a 4-inch minimum diameter breast high for spruce and a 6-inch minimum diameter for balsam and jack pine and is expressed on a cordage basis, a cord containing 85 cubic feet of solid wood. The estimate for white and red pine is 7,015,000,000 board feet, Doyle scale. The minimum diameter, breast high, of trees entering into this is 8 inches.

The above estimate excludes the Ottawa-Huron, the Coastal Plain and Central Patricia regions.

Forest Type and Age Class Distribution

The general division of the province on the basis of forest types allots 39 per cent of the area to the mixed type, 22 per cent to the coniferous type, 19 per cent barren and muskeg, 8 per cent recent burn, and 12 per cent water. The mixed type is 34 per cent mature, 26 per cent second growth and 40 per cent young growth. The coniferous type is 69 per cent mature, 15 per cent second growth and 16 per cent young growth. (Table 6).

These figures do not include the Algoma Extension of the Ottawa-Huron region, the Lake Superior, the Coastal Plain, nor Central Patricia regions

Age Class Distribution

Of the forest area of the province, 33 per cent is occupied by mature stands of timber, 15 per cent by second growth, 23 per cent by young growth, while 9 per cent is recent burn and 20 per cent barren and muskeg.

The general classification of the forest into age classes shows 33 per cent mature, 38 per cent immature and 29 per cent non-forested or not at the present time covered with forests of potential value (Table 7).

Timber Ownership Conditions

The total area of the province under timber license is 13,644,800 acres, while 33,966,000 acres is under pulpwood license, giving 47,610,800 acres on which cutting rights are held, or somewhat less than half of the forest area of the province. The timber licenses and pulpwood licenses in some cases cover the same areas for different species.

VI. APPENDIX

LIST OF FOREST TREES MENTIONED

Pinus—P. strobus L. (white pine); P. resinosa Ait. (red or norway pine); P. banksiana Lamb. (jack or banksian pine).

Larix—L. laricina (Du Roi) Koch (tamarack or larch).

Picea—P. canadensis (Mill) BSP. (white spruce); P. mariana (Mill) BSP. (black spruce).

Abies—A. balsamea (L) Mill. (balsam or fir).

Tsuga—T. canadensis (L) Carr. (hemlock).

Thuja—T. occidentalis L. (white cedar or arbor vitae).

Populus—P. balsamifera L. (balsam poplar or balm of gilead); P. grandidentata Michx. (large-toothed aspen); P. tremuloides Michx. (aspen).

Betula—B. alba var. papyrifera (Marsh) Spach (white or paper or canoe birch); B. lutea Michx. f. (yellow or cherry or black birch).

Ostrya—O. virginiana (Mill) K. Koch (hornbeam or ironwood).

Fagus—F. grandifolia Ehrh. (beech).

Quercus—Q. alba L. (white oak); Q. rubra L. (red oak).

Ulmus—U. americana L. (white elm).

Prunus—P. pennsylvanica L. f. (red, pin or bird cherry); P. serotina Ehrh. (black cherry).

Acer—A. saccharum Marsh. (hard, sugar or rock maple); A. spicatum Lam. (mountain maple); A. rubrum L. (red or soft maple).

Tilia—T. americana L. (basswood).

Table 3

Classified List of Forest Surveys in Ontario

CLASS A—FOREST TYPE AND AGE CLASS DISTRIBUTION MAPPED; TIMBER ESTIMATED

1. By the Ontario Forestry Branch:

1. James Bay	1922	8,641,036 acres	
2. Missinaibi	1922	2,554,156 "	
3. Mississagi	1923	2,659,228 "	
4. Nipigon (East)	1924	1,772,835 "	
5. Nipigon (West)	1924	5,129,942 "	
6. Groundhog	1925	1,347,982 "	
7. Opasatika	1925	628,080 "	
8. Kabinakagami Lake	1925	466,560 "	
9. Pic and Pagwachuan	1925-26	1,585,390 "	
10. English River	1926	1,323,337 "	
11. Bruton Township	1926	40,965 "	
12. Rainy River	1927-28	4,050,941 "	
13. Timagami West	1928	732,638 "	
14. Loch Lomond	1928	18,462 "	
		30,951,552 acres	

2. By Private Agencies:

30. Total area		7,129,449 acres	
			38,081,001 acres

CLASS B—FOREST TYPE AND AGE CLASS DISTRIBUTION MAPPED; NO ESTIMATE

1. Aerial Sketching—By Ontario Forestry Branch:

15. Lake St. Joseph	1921	2,220,000 acres	
16. Kapuskasing-Missinaibi	1925	1,478,220 "	
17. Hayward Block	1926	373,366 "	
18. Grant-Jobrin Area	1926	257,240 "	
19. Nipigon	1924	1,152,000 "	
			5,480,826 acres

2. Aerial Photography—By Dominion Topographical Surveys:

20. Kenora-Patricia portion ..... 13,005,000 acres

3. Ground Work—By Ontario Forestry Branch:

21. Ottawa-Huron	1920	7,213,372 acres	
22. Eastern Forest Survey	1921	1,616,775 "	

—By Commission of Conservation:

23. Trent Watershed	1912	1,345,546 acres	
			10,175,693 acres

Table 3—Continued

CLASS C—TIMBER ESTIMATED; NO MAPPING

1. By Ontario Forestry Branch:

24. Longlac	1921	2,161,279 acres	
2. By Woods and Forests Branch:			
25. Black Sturgeon Pulp Limit		619,520 acres	
26. Dryden-Wabigoon Pulp Limit		771,840 "	
27. Nipigon Pulp Limit		793,600 "	
28. Pic River Pulp Limit		896,000 "	
29. Nagagami Pulp Limit		1,472,000 "	
			6,714,239 acres
Total Area of Surveys			73,456,759 acres

Note:—Number preceding the title of survey refers to the location of that survey on the map "Forest Surveys in Ontario."

Table 4

SUMMARY OF FOREST AREAS

Forest Region	Total Area Acres	Present Agricultural Acres	Forest Area Acres
1. Ottawa-Huron	11,626,000	2,536,883	9,089,117
Algoma Extension	5,979,693	1,048,983	4,930,710
2. Sudbury	10,741,525	290,280	10,451,245
3. Rainy River	8,415,412	1,355,845	7,059,567
4. Lake Superior	6,271,979	315,840	5,956,139
5. Central Divide	22,871,410	.....	22,871,410
Kenora Extension	33,750,450	556,540	33,193,910
6. Clay Belt	16,928,254	2,361,715	14,566,539
Nipigon Extension	1,753,718	.....	1,753,718
Total	118,338,441	8,466,086	109,872,355
7. Coastal Plain (a)	59,553,354	.....	.....
8. Central Patricia (b)	40,128,487	.....	.....
Total	99 681,841		
Total for Regions	218,020,282		
Large Lakes (c)	2,875,346		
Grand Total	220,895,630		

(a) Inaccessible.
(b) Conditions unknown.
(c) Lakes included—Nipissing, Abitibi, Rainy, Lake of the Woods, Nipigon, Lac Seul and Lake St. Joseph.

Table 5

SUMMARY OF TIMBER RESOURCES OF ONTARIO

Forest Region	Total Forest Acres	Spruce Cords 4 inches, D.B.H., and up	Balsam Cords 6 inches, D.B.H., and up	Jack Pine Cords 6 inches, D.B.H., and up	White and Red Pine Board Feet (Doyle Rule) 8 inches, D.B.H., and up	Maple Board Feet (Doyle Rule)	Yellow Birch Board Feet (Doyle Rule)
1. Ottawa-Huron (a)	9,089,117	.....	.....	.....	.....	.....	.....
Algoma Extension	4,930,710	6,395,484	2,459,801	4,919,603	231,262,203	86,335,400	335,445,000
2. Sudbury	10,451,245	11,921,374	4,698,603	11,290,755	5,855,529,181	.....	.....
3. Rainy River	7,059,567	6,964,376	609,501	7,193,920	928,273,872	.....	.....
4. Lake Superior	5,956,139	8,079,590	952,767	994,628	.....	.....	.....
5. Central Divide	22,871,410	51,576,545	7,311,154	26,462,594	.....	.....	.....
Kenora Extension	33,193,910	43,678,866	4,363,085	26,685,504	.....	.....	.....
6. Clay Belt	14,566,539	44,028,092	4,655,593	906,186	.....	.....	.....
Nipigon Extension	1,753,718	7,913,317	730,559	636,825	.....	.....	.....
7. Coastal Plain (b)	.....	.....	.....	.....	.....	.....	.....
8. Central Patricia (c)	.....	.....	.....	.....	.....	.....	.....
Grand Total	109,872,355	180,557,644	25,781,063	79,090,015	7,015,065,256	86,335,400	335,445,000

(a) No estimate made.
(b) Low yield and inaccessible.
(c) Conditions unknown.

Table 6

FOREST TYPE AND AGE CLASS DISTRIBUTION

Per Cent.

Forest Region	MIXED				CONIFEROUS				NON-FORESTED		
	Mature	Second Growth	Young Growth	Total	Mature	Second Growth	Young Growth	Total	Barren and Muskeg	Water	Recent Burn
1. Ottawa-Huron (a)	30	38	31	83	41	56	3	4	11	..	2
Algoma Extension (b)	..	..	..	..	..	..	..	..	..	..	..
2. Sudbury	56	16	28	45	70	15	15	38	2	10	5
3. Rainy River	11	35	54	16	35	25	40	34	2	19	29
4. Lake Superior (c)	..	..	..	..	..	..	..	..	..	..	..
5. Central Divide	43	23	34	52	87	8	5	26	6	10	6
Kenora Extension (d)	24	19	57	19	53	22	25	18	39	23	1
6. Clay Belt	57	1	42	19	94	1	5	33	19	5	24
Nipigon Extension	54	7	39	36	99	..	1	45	7	10	2
7. Coastal Plain (e)	100	..	..	2	100	..	..	6	88	4	..
8. Central Patricia (c)	..	..	..	..	..	..	..	..	..	..	..
Province	34	26	40	39	69	15	16	22	19	12	8

(a) Land area only.
(b) No available data.
(c) Insufficient data.
(d) Dominion Photographic Survey not included.
(e) Not included in average for province.

Table 7

FOREST AGE CLASS DISTRIBUTION

Per Cent.

Forest Region	Mature	Second Growth	Young Growth	Recent Burn	Barren and Muskeg
1. Ottawa-Huron	22	31	34	2	11
Algoma Extension (a)	..	..	..	..	..
2. Sudbury	58	14	21	5	2
3. Rainy River	17	17	28	36	2
4. Lake Superior (a)	..	..	..	..	..
5. Central Divide	53	16	20	5	6
Kenora Extension	38	7	20	1	34
6. Clay Belt	47	3	9	24	17
Nipigon Extension	72	3	16	2	7
7. Coastal Plain (b)	7	..	..	..	93
8. Central Patricia (a)	..	..	..	..	..
Province	33	15	23	9	20

(a) Insufficient data.
(b) Not included in averages for province.

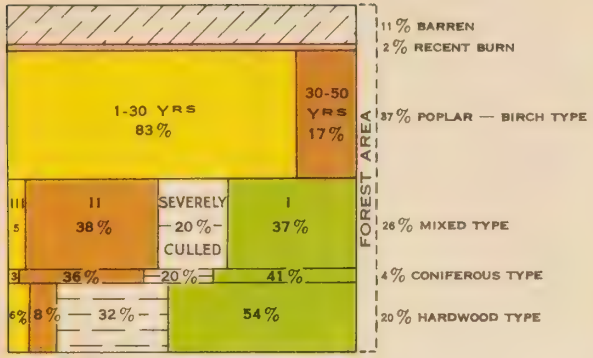
Table 8

TIMBER LICENSED AREA*

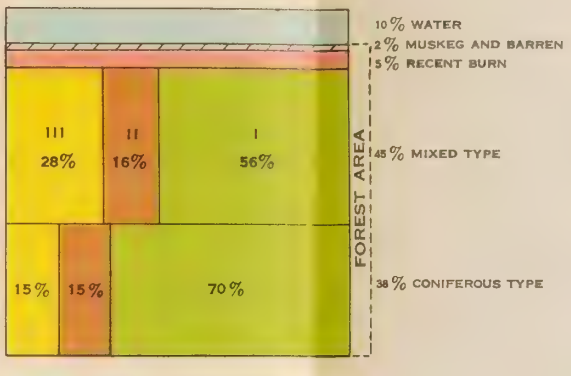
Forest Region	Acres Under Lumber License	Acres Under Pulp License	Total Acres
1. Ottawa-Huron	3,393,920	.....	3,393,920
Algoma Extension	2,081,280	599,040	2,680,320
2. Sudbury	2,380,160	5,388,800	7,768,960
3. Rainy River	1,446,400	281,600	1,728,000
4. Lake Superior	321,920	4,821,120	5,143,040
5. Central Divide	2,177,280	7,301,120	9,478,400
Kenora Extension	1,125,120	7,114,880	8,240,000
6. Clay Belt	708,480	6,936,960	7,645,440
Nipigon Extension	10,240	1,522,560	1,532,800
7. Coastal Plain	.....	.....	.....
8. Central Patricia	.....	.....	.....
Total	13,644,800	33,966,080	47,610,880

*May 1st, 1929.

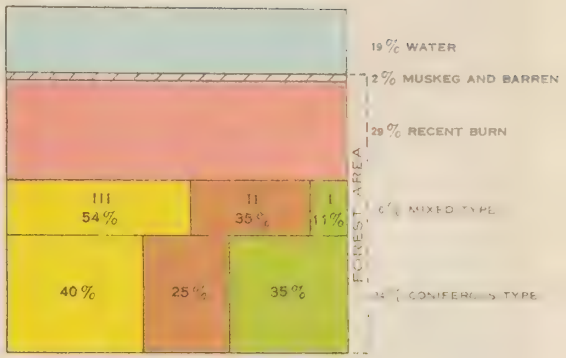
FOREST TYPE AND AGE CLASS DISTRIBUTION BY REGIONS



NO. 1 — OTTAWA — HURON



NO. 2 — SUDBURY



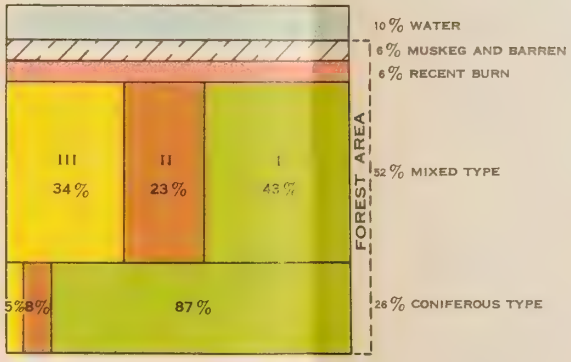
NO. 3 — RAINY RIVER

LEGEND

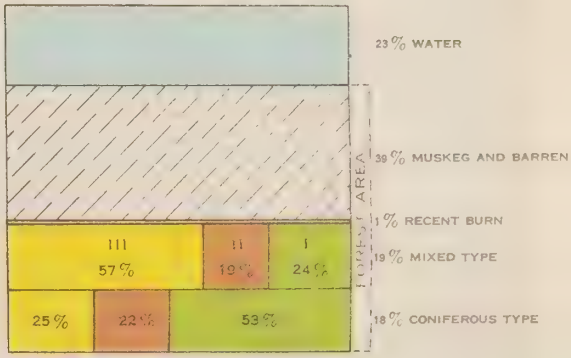
I — MATURE

II — SECOND GROWTH

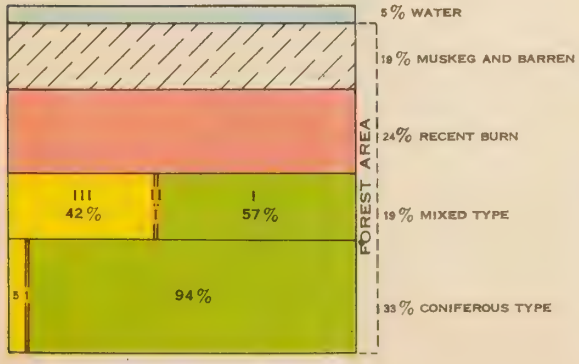
III — YOUNG GROWTH



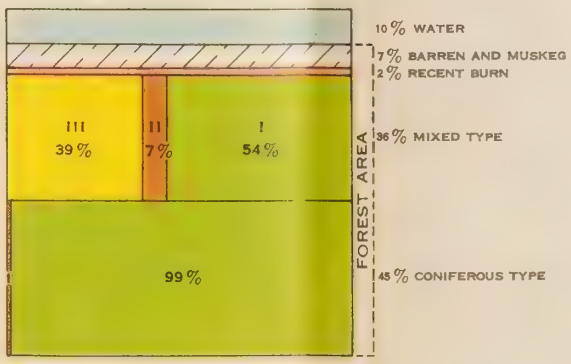
NO. 5 — CENTRAL DIVIDE



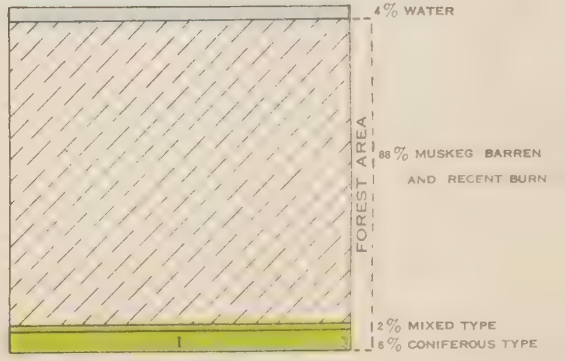
NO. 5A — CENTRAL DIVIDE
KENORA EXTENSION



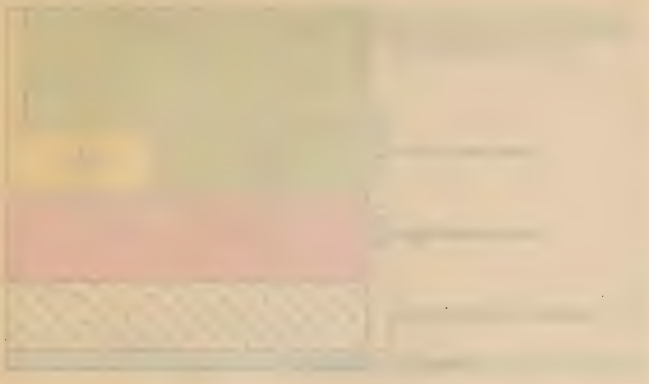
NO. 6 — CLAY BELT

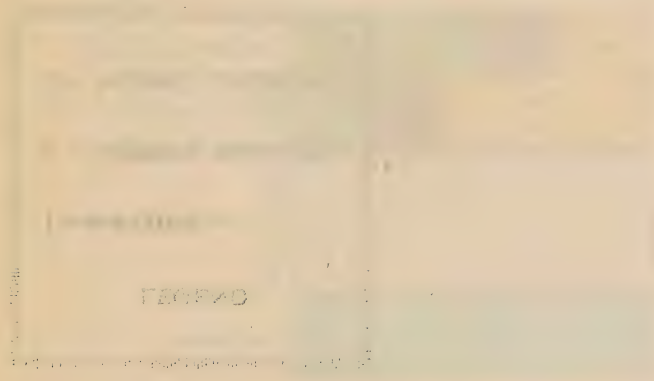


NO. 6A — CLAY BELT
NIPIGON EXTENSION

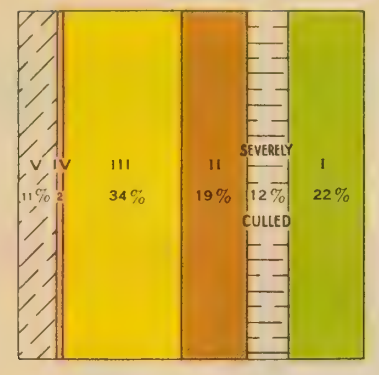


NO. 7 — COASTAL PLAIN





FOREST AGE CLASS DISTRIBUTION BY REGIONS



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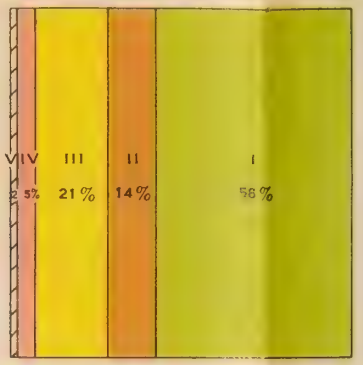

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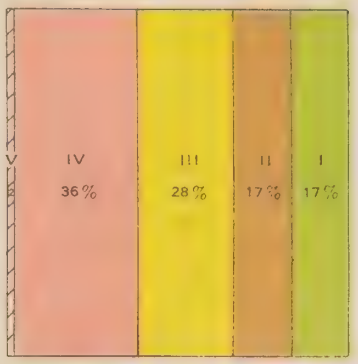


NO. 3 – RAINY RIVER

LEGEND

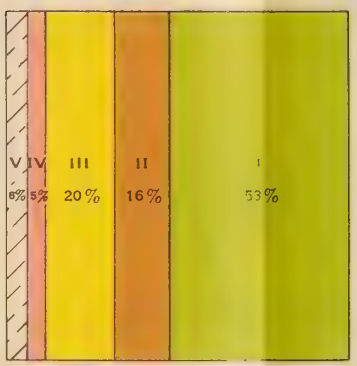
I – MATURE

II – SECOND GROWTH

III – YOUNG GROWTH

IV – RECENT BURN

V – BARREN AND MUSKEG



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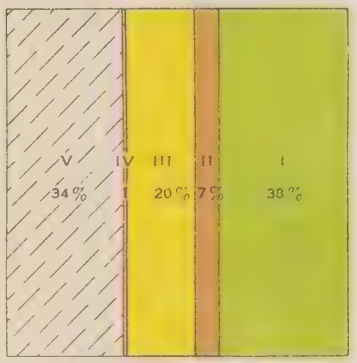
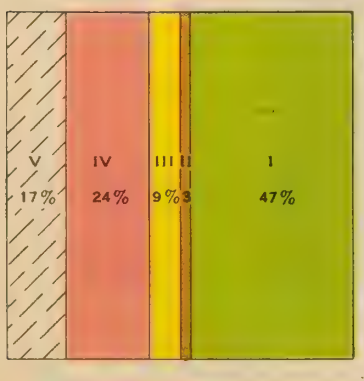
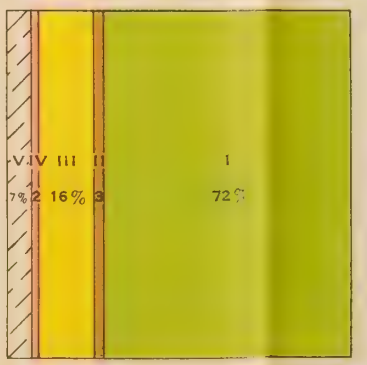


NO. 5A – CENTRAL DIVIDE

KENORA EXTENSION

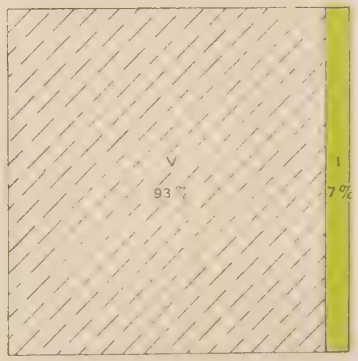


NO. 6 – CLAY BELT



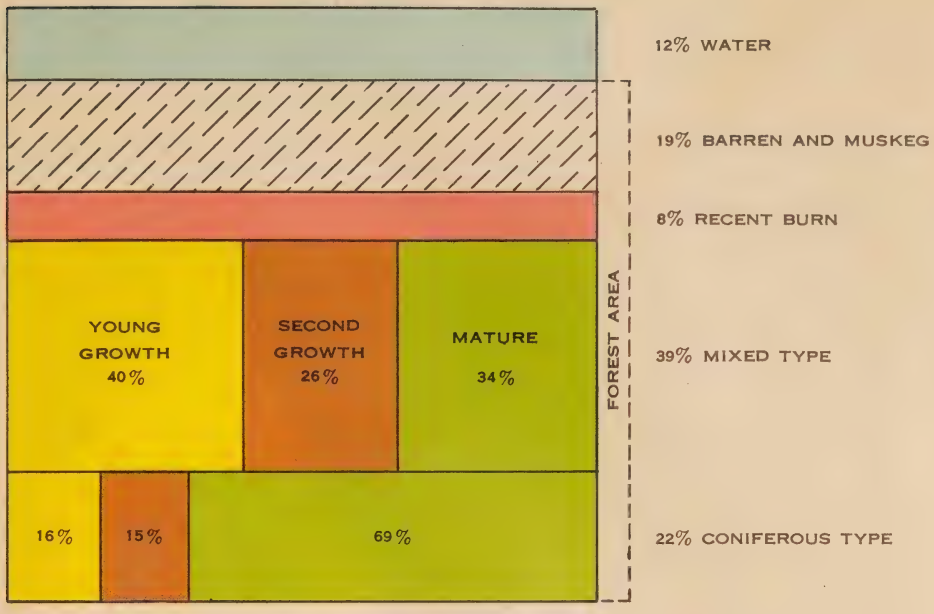
NO. 6A – CLAY BELT

NIPIGON EXTENSION

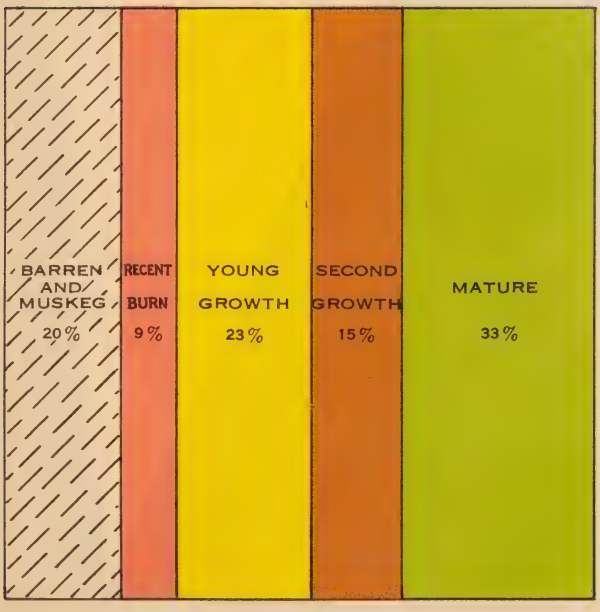


NO. 7 – COASTAL PLAIN

SUMMARY OF FOREST CONDITIONS OF THE PROVINCE



*FOREST TYPE AND AGE CLASS DISTRIBUTION



*FOREST AGE CLASS DISTRIBUTION

*COASTAL PLAIN AND CENTRAL PATRICIA REGIONS NOT INCLUDED

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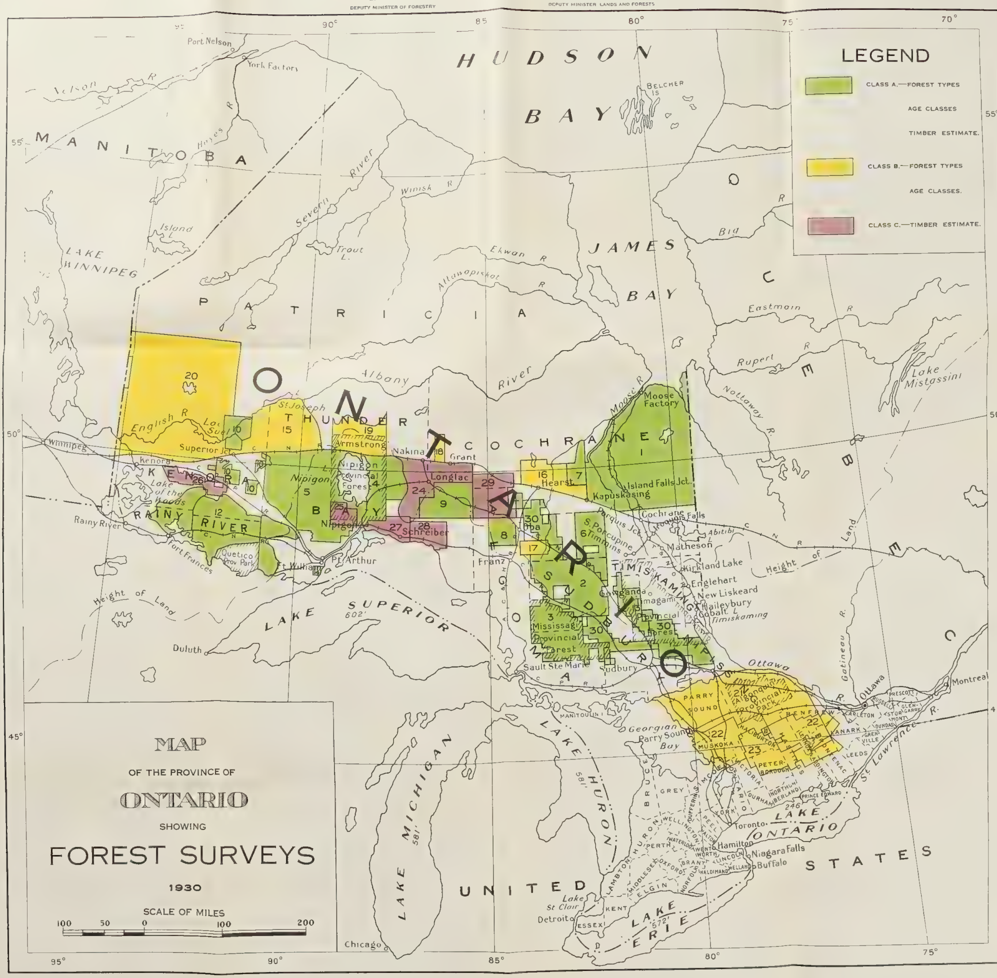

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LEGEND

1. OTTAWA—HURON
   - A.—ALGOMA EXTENSION
2. SUDBURY
3. RAINY RIVER
4. LAKE SUPERIOR
5. CENTRAL DIVIDE
   - A.—KENORA EXTENSION
6. CLAY BELT
   - A.—NIPIGON EXTENSION
7. COASTAL PLAIN
8. CENTRAL PATRICIA

MAP

OF THE PROVINCE OF

ONTARIO

SHOWING

FOREST REGIONS

1930

SCALE OF MILES

100 50 0 100 200